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ABSTRACT

Awareness of the need for more effective instruction for heterogeneous groups of students has resulted in the development of the "mastery learning" model through which students are provided with the additional time necessary to achieve mastery of the content to be learned. The mastery learning model does not, however, provide a conceptual framework through which teachers can make decisions about the alternative instructional methodologies to offer each student. A second type of learning theory is known as "learning styles." A variety of models have been developed, all of which are based on theories of cognitive style. The combination of a learning styles model and the mastery learning concept holds great promise for improved programs that can provide for the learning styles of the learners. A need exists, however, for content specification. In vocational education, the competency-based vocational education (CBVE) model provides the content specification required for the implementation of an effective, success-oriented program. Several such programs have been implemented in vocational-technical institutions around the country. (Two such programs are in White Bear Lake, Minnesota and in Appleton, Wisconsin.) Both of these programs involve assessment of learning styles through computerized educational cognitive-style mapping of students and matching them with alternative instructional methodologies prescribed by the resulting cognitive map.

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Information Series No. 254

LEARNING STYLES: APPLICATIONS IN VOC ED

by

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The Ohio State University
1960 Kenny Road
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1983

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FOREWORD

Learning Styles: Applications in Vocational Education reviews the literature on cognitive, educational cognitive, and learning styles and applies learning styles theory to the mastery learning and competency-based vocational education models. Effective programs are described, and resources for program implementation are provided.

This paper is one of ten interpretive papers produced during the fifth year of the National Center's knowledge transformation program. The review and synthesis in each topic area is intended to communicate knowledge and suggest applications. Papers in the series should be of interest to all vocational educators including teachers, administrators, federal agency personnel, and researchers.

The profession is indebted to Dr. William C. Knaak for his scholarship in preparing this paper. Dr. Knaak is Associate Professor in the Vocational-Technical Education Department of the College of Education at the University of Minnesota. He was formerly Superintendent of the 916 Vo-Tech Institute at White Bear Lake, Minnesota.

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in Vocational Education

EXECUTIVE SUMMARY

American public schools have become the target of increasing criticism in recent years. In an era when rapidly advancing technology is creating a labor market in which there is little demand for unskilled workers, many young Americans are leaving school virtually devoid of marketable skills.

The traditional group instructional methods that are producing these results are clearly less than effective. Individual differences have been provided for through default—the elimination of students—or through the introduction of alternative content rather than alternative instructional methodologies. Increased awareness of the need for more effective instruction for heterogeneous groups of students has resulted in the development, during recent decades, of the "mastery learning" model through which students are provided with the additional time necessary to achieve mastery of the content to be learned. Individualization of instruction is necessary to the implementation of such a model. The mastery learning model does not, however, provide a conceptual framework through which teachers can make decisions about the alternative instructional methodologies to offer to each student. Lacking a systematic model, this decision-making process has remained at the trial-and-error stage of development.

A second type of learning theory developed during the past three decades provides the decision rules needed for selecting the alternative instructional methodologies to use with each individual student. Such programs are viewed by these institutions as practical, effective techniques that help them identify potential learning problems and avoid them, match students and courses of study, reduce dropout rates, and improve students' overall learning performance.

This type of theory is known as "learning styles." A variety of models have been developed, all of which are based to some relative degree in theories of cognitive style.

The combination of a learning styles model and the mastery learning concept holds great promise for improved programs that can provide for the temporal and stylistic needs of learners. A need exists, however, for content specification. In vocational education the competency-based vocational education (CBVE) model provides the content specification required for the implementation of an effective, success-oriented program.

Several such programs have been implemented in vocational-technical institutions around the country. One is in progress at the 916 Vo-Tech Institute in White Bear Lake, Minnesota. This program involves assessment of learning styles through computerized educational cognitive style mapping of students who are not achieving mastery quickly and matching them with the alternative instructional methodologies prescribed by the resulting "cognitive map." The program has produced inservice training modules on the use of cognitive maps.

A second program is one that has been operating since 1974 at the Fox Valley Technical Institute in Appleton, Wisconsin. All incoming students are "mapped." Whereas participation is not required, a majority of the instructors voluntarily implement the program.

INTRODUCTION

In recent years, American public shools have increasingly become the target of criticism. Nearly every day the news media present new evidence that society is becoming less tolerant of the public schools' inability to educate its youth effectively. Americans are no longer willing to support a system that educates only those students who learn easily, quickly, and willingly. Columnist Max Lerner (1979) provides the following succinct statement of the current public attitude toward the educational system:

> The bleak facts are well known. Since the 1960s there has been a decline in the capacity of young Americans to read, write, reckon, and reason. The present-day armed forces are shockingly illiterate. An economy with an advanced technology finds itself having to communicate it at times in comic book form. (p. 5)

In an era when rapidly advancing technology is creating a labor market in which there is little demand for unskilled workers, many young Americans are leaving school virtually devoid of marketable skills. Dunn and Dunn (1978) assert that "increasing attention is being focused on the many functional illiterates who are awarded high school diplomas and then are pushed out into the job market, only to be condemned to unemployment, marginal employment, or welfare. Public concern has moved from voter unhappiness at school board meetings to taxpayer suits charging educational malpractice" (pp. 1-2).

Cronbach (1967) notes that in the "early years of the century there was a largely fixed curriculum starting with the common branches of knowledge, and proceeding through an academic high school program and a college liberal arts program. Individual differences were taken into account chiefly by eliminating students. Less successful students dropped out along the way" (p. 8).

In addition to the "individualization" accomplished through default, some provision for individual differences was planned—through alternative content rather than through instructional innovations. According to Cronbach (1967), "When the high school began to serve all youngsters—that is, when the nation began fifty years ago to regard dropouts as undesirable rather than as good riddance, the influx of unselected students called for a radical alteration of program. Consequent to such thinking, schools introduced vocational and homemaking curriculum, and new courses were designed" (p. 8).

Over the years, educators have fallen into the trap of specifying the quality of education (the effectiveness of teachers, instructional methodologies, instructional materials, and curricula) in terms of group results. Persistently asked are such questions as, "What is the best instructional method for the group?" or "What is the best instructional material for the group?" or "Who is the best teacher for the group?" Group instruction has been extensively investigated. Cross (1976) suggests, however, that such studies are misdirected:

> The research on teaching effectiveness has been inconclusive and disappointing because . . . we were asking the wrong questions. When we ask whether discussion is

better than lecture, whether television is as good as a live teacher, whether programmed instruction is an improvement over traditional methods, we find that for that mythical statistical average student it seems to make little difference how we teach. But when we look at the data student by student, it is clear that some students improve, some remain unaffected, and a few actually regress under various learning conditions. The very process of averaging the pluses, the minuses, and the non-changers wipes out the message that different methods work for different students. (p. 111)

Research demonstrates that group instruction is an ineffective and inappropriate method of instruction—especially in highly sequential subjects (Brophy and Goode 1970). Group instruction is also elitist. Small numbers of students receive the majority of the resources. Teachers tend to instruct with certain students in mind—those who are attentive and nod at the right moment. They participate and are therefore reinforced for learning.

Traditional notions that students who fail to achieve in school either do not want to learn or are unable to learn are giving way to a different attitude:

> In the not too distant past, schools and their teachers were protected by the fairly widespread belief that students who had not learned had not paid attention. . . . During the past decade, however, the public [attitude] has gradually undergone a complete reversal, and today, low achievement is blamed directly on the schools, their teachers, and the instructional program or methods being used. (Dunn and Dunn 1978, p. 1)

The focus of the most widely recognized efforts to respond to this perceived need for a change in educational methodology has been on individual differences with respect to the time individual students need to achieve educational objectives. According to Cross (1976), "Most of the creative energy that has gone into the instructional revolution so far has been directed toward the seemingly modest goal of breaking the lockstep of education with respect to time requirements" (p. 111). A number of researchers have investigated this phenomenon, and they estimate that it may take some students up to five times as long as others to achieve mastery of a given educational objective (Atkinson 1968; Bloom 1976; Carroll 1963; Glaser 1968). Research suggests that, given (1) adequate time for learning and (2) favorable learning conditions, 95 percent of students can achieve mastery on almost any educational criterion (Block 1971; Bloom 1976). "Mastery learning" is the term that has evolved to designate this educational strategy.

Mastery Learning

Mastery learning means that required competencies are defined, instruction is designed to shape those competencies, instruments are designed to ascertain when individuals achieve competence, and the process is carefully monitored. Further, learning activities are packaged in modules that permit continual feedback of information on student progress. If students do not immediately achieve mastery, alternative learning approaches are introduced.

Mastery learning is a pervasive, insistent instructional model. According to Bloom (1976),

> There are many versions of mastery learning in existence at present. All begin with the notion that most students can attain a high level of learning capability if instruction is approached sensitively and systematically, if students are helped when and where they have learning difficulties, if they are given sufficient time to achieve mastery, and if there is some clear criterion of what constitutes mastery. (p. 4)

Block and Burns (1977) describe the common elements of mastery learning systems as follows:

- The learners understand the nature of the learning task and the procedures they are to follow in learning it.
- Specific instructional objectives are formulated to guide the learning task.
- Subobjectives are subdivided into discrete learning units and student achievement is assessed at the end of each unit.
- The teacher provides the student with feedback on errors after each assessment.
- Teachers provide the additional time some students need to achieve mastery.
- Teachers provide alternative instructional methodologies for students who do not achieve mastery through a single approach.
- Small groups of students meet to review test results and assist each other with learning tasks.

Much of the well-known research in mastery learning was conducted by Benjamin Bloom (1976). In Bloom's experiments, a "mastery" group and a group of students who received traditional instruction were compared as they progressed through units of instruction. The material was initially presented to both groups of students through traditional group instructional activities. (Twenty percent of the students in each group consistently achieved mastery with that instructional treatment.) The entire control (traditional) group was then presented with the next instructional unit. Students in the mastery group who had not achieved mastery, however, received additional alternative educational treatments during the same time period. A number of interesting results were obtained:

- Some students in the mastery group initially took five times as long as the fastest students to achieve mastery. The time they needed declined to three times that of others by the midpoint of the instructional series, and to one and one-half times by the end of the series.
- In the mastery group, 80 percent of the students achieved mastery but only 20 percent of the students in the traditional group achieved mastery.
- Initially, 60 percent of the students in each group were actively making efforts to learn. By the end of the experiment, 85 percent of the mastery group and 40 percent of the traditional group were doing so.

Clearly, the mastery learning model provides students with increased opportunities to succeed, and this success stimulates their desire to learn. A large proportion of slower learners learn as well as the faster learners. When the slower learners succeed in attaining the same level of mastery as the faster learners, their learning is equal to that of the rapid learners. Bloom makes the following points about slower learners who achieve mastery:

- They learn equally as complex and abstract ideas as more rapid learners.
- They can apply these ideas to new problems equally as well as rapid learners.

- They retain the ideas equally as well as rapid learners.
- Their attitude toward the subjects in which they achieve mastery are as positive as those of the faster learners.

According to Hyman and Cohen (1979), "The jury is in on mastery learning. After 15 years of experimentation and experience in more than 3000 schools, learning for mastery is consistently more effective than traditional instruction" (p. 104). Even greater effectiveness may be possible. Mastery learning, based as it is primarily around concerns about the temporal dimension in learning, does not provide a model for making decisions about the alternative instructional methodologies to be implemented in the additional instructional time specified.

Bloom (1976) and others recognize that the problem of dealing with individual differences in learning is more complicated than providing additional time for slow learners. Cross (1976) says that "people are fast learners in one subject perhaps and slow in another, or they learn rapidly by one method and more slowly when a different approach is used" (p. 111). Bloom (1976) refers to the provision of different approaches as "favorable learning conditions." An attempt to provide these favorable learning conditions for all students is, in the absence of a coherent and comprehensive learning model, implemented on a trial-and-error basis. Not one, but several, such cogent learning models have resulted from the work of psychologists and educators, and are generally referred to as educational cognitive styles or learning styles theories. A discussion of the context from which these theories developed follows.

COGNITIVE, EDUCATIONAL COGNITIVE, AND LEARNING STYLES

During the same era as the development of the mastery learning model (which deals with differences in temporal requirements for learning) theorists devised various conceptualizations of individual differences in cognitive or learning styles (which deal with stylistic requirements for learning). The early research was that of psychologists, who were interested in differences in personality, perception, or in mental processes. This work was reported, for the most part, in the literature on cognitive styles.

Cognitive Styles

Through the work of a large number of researchers, a wide variety of ways of viewing cognitive style dimensions have been identified. Cross (1976) summarizes cognitive style dimensions as follows:

> People see and make sense of the world in different ways. They give their attention to different aspects of the environment; they approach problems with different methods for solution; they construct relationships in distinctive patterns; they process information in different but personally consistent ways. . . . Style has a broad influence on many aspects of personality and behavior: perception, memory, problem solving, interests, and even social behaviors and self-concepts. (pp. 115-116)

Some of the earliest work to become the basis of a model of cognitive style (and to be applied later to learning style) was that of Carl Jung (1923), who studied personality differences and published his theories as *Psychological Types*. Jung observed characteristic mental processes in use—sensing, intuiting, thinking, and feeling. Individuals of each of the types Jung describes use all of these processes, but display a relative preference for each and a characteristic attitude in which to use them (Lawrence 1979). These characteristic attitudes are extraversion and introversion.

Jung's theories were applied to the definition of individual psychological types by Isabel Briggs Myers, who developed the Myers-Briggs Type Indicator* and published *Gifts Differing* (1979). According to Lawrence (1979), type theory suggests that motivation may be viewed as being comprised of four parts, corresponding to the following dimensions of type:

- The extraversion-introversion preference shows the broad areas of a student's *natural interest*.
- The sensing-intuition preference reveals basic *learning style* differences.

*For more information see the entry in Appendix A for the Center for Applications of Psychological Type, Inc.

- The thinking-feeling dimension shows patterns of *commitments and values* of the student.

- The judging-perceiving dimension shows *work habits*. (p. 24)

Another early researcher into how people see and make sense of the world was Viktor Lowenfeld, who identified individuals of two perceptual types and published an instrument for identifying them—"Tests for Visual and Haptic Aptitudes"—in 1945. Lowenfeld (1945) says that visual perceptual types tend to use their eyes as the main source of sensory impressions. They are perpetual observers, usually approaching things from their appearance. They tend to transfer physical and touching experiences into visual ones. A haptic individual, on the other hand, is a person who has normal vision, but who uses the eyes for sensory impressions only when compelled to do so, preferring to rely on touch and muscular sensations.

Lowenfeld's theory was applied to learning situations in a study by Ausburn (1979), who concludes that "the visual perceptual type tends to display the cognitive style traits of field independence, reflectivity, and sharpening; while the haptic type tends to display field dependence, impulsivity, and leveling" (p. 29). The Ausburn study is an attempt to correlate the two dichotomies of cognitive style—perception and processing.

The field dependence-independence perceptual dimension of cognitive style was identified in 1954 by Herman Witkin, who is known as the father of cognitive style. Witkin and his associates (1954) were interested in the distinction between global and analytic perception. Their work reveals that the field independent person consistently approaches tasks in an analytical way, separating elements from their background. Field-dependent individuals, on the other hand, approach situations in a global way, seeing the whole situation instead of the parts, perhaps to the extent that they do not differentiate themselves sharply from their environment. They tend to be sensitive to others' opinions and behavior, and they are dependent upon others for their own orientation (Cross 1976).

The reflectivity-impulsivity dimension of information processing noted by Ausburn was extensively studied by Kagan and associates (1964). Kagan (1965) notes that individuals tend to display consistency in the speed with which they select hypotheses and process information. Impulsive individuals tend to offer the first thought that occurs to them (even though it often proves to be incorrect or inappropriate), and reflective individuals tend to ponder a variety of possibilities before deciding on one (Cross 1976).

The third set of polarities comprising a dimension of cognitive style that Ausburn considers is leveling-sharpening. Early work on this dimension was published by Holzman and Klein (1954) and Gardner (1959). They report that individuals at the leveling extreme of the continuum tend to merge similar memories, and "sharpeners" sharply differentiate even similar events and may actually judge the present to be less similar to the past than is in reality the case (Cross 1976).

These early ideas about perceptual and processing dimensions of cognitive styles are but a few of the major ones. During the past three decades a large number of such dimensions have been identified by psychological researchers. An excellent summary of this research, developed by Kirby (1979), is reproduced in table 1.

During the past two decades a great deal of interest developed in the application of various models of cognitive functioning to educational practice. One of the early researchers to work in the new field was Joseph Hill, who coined the term "educational cognitive style."

TABLE 1

DIMENSIONS OF COGNITIVE STYLE

MODEL	DESCRIPTION	REFERENCES
Field dependent/ independent	A global versus analytical way of perceiving. Entails the ability to perceive items without being influenced by the background.	Witkin et al. (1954); Witkin (1976)
Analytical/ non-analytical conceptualizing	Analytical style entails differentiating attributes or qualities. Non-analytical style responses may be more relational or thematic.	Kegan et al. (1964); Messick and Kogan (1963)
Impulsivity/ reflectivenses	Impulsivity is characterized by quick responses, reflectivity by more deliberate, slower responses. The impulsive person is quicker but makes more errors.	Kagan (1965)
Risk taking/ caution	Risk taking is characterized by taking risks even when the odds for success are poor. Caution is characterized by reluctance to take chances except when the probability of success is great.	Kogan and Wallach (1964)
Perceptive-receptive/ systematic-intuitive	The inclination to assimilate data into concepts or precepts previously held (preceptivity) versus the tendency to take in data in raw form (receptivity). The inclination to develop clear sequential plans (systematic) versus the tendency to develop ideas freely from data and to skip from the part to the whole (intuitive).	McKenney and Keen (1974); [Schwartz (1972) identified a related style that considers preceptive ("generalizing") and receptive ("particularizing")]
Leveling/ sharpening	Individual variations in assimilation in memory. The leveler tends to assimilate new stimuli into previous categories, while the sharpener tends to differentiate new information from old.	Gardner (1959)

MODEL	DESCRIPTION	REFERENCES
Cognitive complexity/ simplicity	Differences in tendency to see the world in a multi-dimensional way. Complexity is characterized by the use of hierarchic integration, while simplicity is shown in the use of dimensions of difference.	Harvey, Hunt, and Schroeder (1961); Kelly (1955)
Scanning/ focusing	Entails identification of relevant versus irrelevant information in attempting to solve a problem.	Schlesinger (1954)
Constricted/ flexible control	Constructed control shows more susceptibility or distraction; flexible control is characterized by resistance to interference.	Klein (1954)
Broad/narrow category width (equivalence range)	Preference for broad categories containing many items, rather than narrow categories containing few items.	Bruner and Tajfel (1961); Kogan and Wallach (1964); Pettigrew (1958)
Tolerance for incongruous or unrealistic experiences	Individual willingness to accept perceptions that vary from conventional experience. Tolerance is characterized by a greater adaptation to unusual perceptions. Intolerance is revealed by the demand for more data before the unusual is accepted.	Klein, Gardner, and Schlesinger (1962)
Strong/weak automatization	Relative ability to perform simple, repetitive tasks compared to what would have been expected from one's general ability level.	Broverman (1964)
Conceptual/ perceptual motor dominance	Conceptual dominance is shown by relative specialization of conceptual behavior vs. relative specialization of perceptual motor behavior.	Broverman (1964)
Sensory modality	Reliance on the different sensory modes, especially kinesthetic (leading to figural or spatial thinking), auditory (leading to verbal thinking), or enactive, iconic, and symbolic modes.	Bruner, Olver, and Greenfield (1966)

MODEL	DESCRIPTION	REFERENCES
Converging/ diverging	Thinking aimed toward logical conclusions and uniquely correct or conventionally best outcomes, versus thinking aimed toward variety and quantity of relevant output.	Getzels and Jackson (1962); Cronback (1968)
Conceptual differentiation	Relative multiplicity of distinctions among concepts (as contrasted to the extent of a single concept's range of reference).	Gardner, Lohrenz, and Schoen (1968)
Compartmentalization	Discrete and relatively rigid categories involving a certain inertia in thinking and possible limitation in production of diverse ideas.	Messick and Kogan (1963); Wallach and Kogan (1965)
Conceptual articulation (conceptual discrimination)	Extent to which stimuli or items of information are treated in dimensional rather than class terms; i.e., extent to which instances of a concept are discriminated from each other in a number of intervals or ordered categories within a concept's range of reference.	Bieri et al. (1966); Schroder, Driver, and Streufert (1967)
Conceptual integration (integrative complexity)	Extent to which categories or dimensions of information are perceived to be integrated in multiple and different ways.	Harvey et al. (1961); Schroder et al. (1967)

SOURCE: Adapted from Kirby (1979)

Educational Cognitive Styles

An applied model of cognitive style, the technique developed by Joseph Hill (1981)* involves a technique known as "educational cognitive mapping." The notion of matching each student's "cognitive map" to the learning resources of the institution is the underlying principle involved in the Hill strategy. Hill's model resulted from a monumental effort to synthesize the then-existing knowledge about cognitive styles with psychological and educational precepts. Hill incorporated this information into a framework he called the "seven educational sciences," which he saw as a hierarchy in which each science was an increment of the previous and in which "cognitive style" was comprised of the previous four. Hill's seven educational sciences are as follows:

1. Symbols and their meanings
2. Cultural determinants
3. Modalities of inference
4. Educational memory (neurological, electrochemical and biological aspects of memory functions)
5. Cognitive style
6. Teaching, administrative, and counseling style
7. Systematic analytic decision making (Kirby 1979, p. 59)

An unusually ambitious effort, the Hill model was designed to provide students with an understanding of their personal educational cognitive style so that they could plan more effectively for their own learning. His main purpose, however, was to match learners with learning environments, and he planned five learning modes in which each course of study was to be delivered—traditional lecture, individual programmed learning, audiotape, videotape, and group seminars with peer tutoring. Students were to choose the instructional methodology for their instruction based on their educational cognitive maps.**

The idea represented by the Hill prototype—matching student learning styles to instructional methodologies based on an assessment instrument or inventory—is the basis of much of the work done by educational researchers and practitioners during the past decade. This work is generally referred to as the study of "learning styles."

Learning Styles

One of the best-known learning styles models among educators in America today is that of Kenneth and Rita Dunn. Their work is based on the assessment of students' preferences related to elements in four categories of stimuli. According to Dunn and Dunn (1978), learners are affected by their (1) immediate environment (sound, light, temperature, and design); (2) own emotionality (motivation, persistence, responsibility, and need for structure or flexibility; (3)

*Prior to his death in 1978, Joseph Hill was president of Oakland Community College in Bloomfield Hills, Michigan. Hill's work was published posthumously in 1981 as *The Educational Sciences—A Conceptual Framework*.

**More information about the Hill model is presented in the final chapter.

sociological needs (self, pair, peers, team, adult, or varied); and (4) physical needs (perceptual strengths, intake, time, and mobility).

The Dunns' model, much like Joseph Hill's, is based on the notion that matching student learning styles to instructional methodologies (teaching styles) is an effective means of enhancing learning. According to Dunn and Dunn (1978), "Several research studies have demonstrated that (1) students can identify their own learning styles; (2) when exposed to a teaching style consonant with the ways they believe they learn, students score higher on tests, fact knowledge, attitude, and efficiency than do those taught in a manner dissonant with their style; and (3) it is advantageous to teach and test students in their preferred modalities" (pp. 4-5). Kirby (1979) notes, "This team of researchers takes the approach of informing students as well as instructors of the range of learning differences so they can take advantage of options in individualized instruction" (p. 72).

The Dunns' work indicates that teachers tend to teach in the style in which they prefer to learn, and that they prefer to teach students who demonstrate their own preferred learning style. The assessment instrument the Dunns developed with Gary Price is called the "Learning Style Inventory." It attempts to document learner preferences in each of the elemental groups they define. Their model has found fairly wide acceptance in elementary and secondary schools. Information about new developments in their learning styles research is disseminated through the National Network on Learning Styles which is directed by Rita Dunn.*

A second widely known learning styles model is that of Anthony Gregorc. *An Adult's Guide to Style* (Gregorc 1982) contains the "Gregorc Style Delineator," which is "the latest approach in an evolution . . . that began in 1970" (p. 1). The instrument is designed to reveal two types of mediation abilities—perception and ordering. This conceptualization provides for both perception and processing, the two dichotomies of cognitive style.

Perception is described by Gregorc as bipolar, being comprised of abstractness and concreteness. Ordering refers to the arranging and systematizing of information—sequence and randomness. These two continually interact to produce four transaction ability channels, designated as—

- CS—Concrete/Sequential
- AS—Abstract/Sequential
- AR—Abstract/Random
- CR—Concrete/Random

According to Gregorc, "Each of these combinations reveals a particular qualitative orientation to life. The predilections are natural and affect not only how we view the world and ourselves, but, also, how we are perceived by that world" (1982, p. 6). Thinking processes of the individuals in each group tends to be as follows: "(1) CS—instinctive, methodical, deliberate, and structured; (2) AS—intellectual, logical, analytical, and rational; (3) AR—emotional, psychic, perceptive, and critical; and (4) CR—intuitive, instinctive, impulsive, and independent" (ibid., p. 30).

*For more information see Appendix A.

A third major learning styles model is unique in that it is based on a learning-process model—the experiential learning cycle—which resulted from the work of social psychologist Kurt Lewin. Developed by David Kolb (1981), this model suggests that learning involves a series of steps, beginning with concrete experience and moving in sequence through reflective observation, abstract conceptualization, and active experimentation.

Kolb hypothesized that learners find themselves in a state of dialectical tension between the two sets of polarities inherent in the two dimensions, concrete to abstract and active to reflective. As learners go about resolving these conflicting learning demands, consistent learning styles emerge. Kolb calls the learners in the four resulting styles (1) divergers, (2) assimilators, (3) convergers, and (4) accommodators. Kolb (1981) and others have used his model and assessment instrument, the "Learning Styles Inventory," primarily at the postsecondary (four-year institution) and graduate levels.

The Kolb model has been introduced into elementary and secondary schools by Bernice McCarthy (1980), who synthesized the work of a number of learning styles researchers and integrated the resulting four learning styles with her synthesis of the work of the leading brain laterality researchers. This produced a model that provides not only for learning styles, but for left and right brain modalities as well. McCarthy published this model as *The 4 Mat System: Teaching to Learning Styles with Right/Left Mode Techniques* (1980). McCarthy and Kolb adapted Kolb's assessment instrument for use with younger students. This adaptation is called "The Learning Styles Inventory." Information about work related to the Kolb model is disseminated by the Lifelong Learning and Adult Development Project directed by David Kolb.*

An excellent summary of the work of the major researchers in learning styles was developed by Dunn and Debello (1981). This summary appears in table 2.

*For more information see Appendix A.

TABLE 2

A COMPARISON OF LEARNING STYLE RESEARCH

Researchers and Their Definitions of Learning Style	Instruments	Applications/Implications
Canfield and Lafferty		
Individual learning style is derived from: (a) academic conditions (relations with instructor and peers); (b) structural conditions (organization and detail); (c) achievement conditions (goal setting, competition); (d) content (numbers, words, etc.); (e) mode of preferred learning (listening, reading, iconic and direct experience); and (f) expectation of performance level (superior through satisfactory).	*Learning Style Inventory:* a self-report instrument based on a rank ordering of choices for each of 30 questions. For use with junior high through adult levels. Approximate administration time: 15 minutes.	Major use to develop instructional materials for whole class or individual students. LSI is viewed as a tool to aid in understanding students' difficulties in completing academic units and for counseling. Emphasis on attitudinal and affective dimensions in the Inventory strengthens such application.
Dunn, Dunn, and Price		
Learners are affected by their: (a) environmental (sound, light, temperature, and the need for either a formal or informal design); (b) emotional (motivation, persistence, responsibility, and the need for either structure or options); (c) sociological (self, pair, peer, team, adult, or varied); and (d) physical (perceptual strengths, need for intake, time of day or night energy levels, and need for mobility) preferences.	*Learning Style Inventory* (LSI): a self-report instrument based on a rank ordering of choices for each of 104 items. For use with grades 3-12. Approximate administration time: 30 minutes. *Productivity Environmental Preference Survey (PEPS):* adult version of the LSI; contains 100 items. Approximate administration time: 30 minutes.	The LSI and the PEPS are designed to diagnose individual learning characteristics. Accompanying manuals suggest prescriptions to complement selected styles to facilitate academic achievement.

TABLE 2, continued

Anthony F. Gregorc		
Learning style consists of distinctive, observable behaviors that provide clues to the functioning of people's minds and how they relate to the world. Those "mind" qualities suggest that people learn in combinations of dualities: (a) concrete-sequential; (b) concrete-random; (c) abstract-sequential; and/or (d) abstract-random. Preferences for a particular set constitutes a learning style.	*Transaction Ability Inventory:* a self-report instrument based on a rank ordering of four words to each of 10 sets. Observation and interviews suggested to aid in categorizing learning preference patterns or modes. For use with upper junior high-adult levels. Approximate administration time: 5 minutes.	Strong emphasis is placed on the matching of instructional materials and methods to meet the range of individual preferences. Gregorc also recommends that selected nonpreferences he utilized at times to encourage students to strengthen those areas.
Joseph E. Hill		
Cognitive style is the unique way in which an individual searches for meaning. It is reflected in the way: (a) qualitative and theoretical symbols are handled; (b) cultural influences affect the meaning given to symbols; and (c) meaning is derived from symbols that are perceived.	*Cognitive Style Interest Inventory:* a self-report instrument based on a rank ordering which measures abstractions, visual, tactile, and auditory perceptions, motor coordination, and social interaction. For use with elementary-adult levels. Approximate administration time: 50 minutes.	Cognitive Style Mapping identifies student strengths and weaknesses through major, minor, and negligible categories. It serves as a basis for developing a Personalized Educational Program (PEP) which utilizes varied instructional modes to match students and the educational task.
David E. Hunt		
Learning style describes students in terms of those educational conditions under which they are most likely to learn and essentially describes the amount of structure individuals require.	*Teacher Assessment of Student Learning Styles:* observations based on student reactions to systematic teacher-introduced changes in structure. *Paragraph Completion Method (PCM):* a semi-projective method which assesses conceptual level. Students write responses to a posed topic. For use with grade 6-adult levels. Approximate administration time: 20 minutes.	Matching educational approaches to student learning style facilitates academic achievement. Conceptual level, in terms of learning style, is a developmental phenomenon which ranges from the "unsocialized" to the "independent." Knowledge of learning style can influence and enhance the development of conceptual level.

TABLE 2, Continued)

David Kolb		
Learning style is a result of hereditary equipment, past experience, and the demands of the present environment combining to produce individual orientations that give differential emphasis to the four basic learning modes postulated in experiential learning theory: Concrete Experience (CE); Reflective Observation (RO); Abstract Conceptualization (AC); and Active Experimentation (AE).	*Learning Style Inventory:* a self-report instrument based on a rank ordering of 4 possible words in each of 9 different sets. Each word represents 1 of the 4 learning modes: feeling (CE); watching (RO); thinking (AC); doing (AE). For use with young adults. Approximate administration time: 5-10 minutes.	Emphasis is placed on individual awareness of personal learning style and available alternative modes. Knowledge of learning style differences should encourage the design of instructional experiences to enhance individual strengths and develop nondominant orientation.
Ramirez and Castaneda		
Cognitive Style Differences (field independent/field sensitive) and tural differences create individual learning styles. Because learning style is not permanently fixed, it is possible to intervene and affect it.	*Child Rating Form:* Direct observation checklist format, yielding frequency of behavior scales, is completed by the teacher; it is suggested that older students can rate themselves. Approximate administration time: varies.	Identification of cognitive style is used both to match and mismatch learning and teaching styles. The goal is to encourage personal "bicognitive ability" that reduces favoring one style over another continually.
Ronald R. Schmeck		
Learning style is the product of the organization of a group of information processing activities that individuals prefer to engage in when confronted with a learning task. Those activities range from (a) deep and elaborative to (b) shallow, repetitive, and reinterative.	*Invertory of Learning Processes:* a 62 item, true-false, self-report inventory grouped via factor analysis into synthesis-analysis, study methods, fact retention, and elaborative processing. Approximate administration time: 20 minutes.	Students should be encouraged to develop a learning style which is thoughtful, deep, and elaborative. Through the use of specific instructional strategies, teachers should discourage shallow reiterative information processing.

APPLICATIONS IN VOCATIONAL EDUCATION

The implementation of instruction based on learning styles requires thoughtful consideration of several issues. One of these issues relates to the way in which individual treatments are applied.

Learning Styles Matches

Whereas some researchers have recommended that learning styles be identified so that instructional activities (or teaching styles) may be matched to each individual's strength, others do not support this strategy. Kolb (cited by Dunn and DeBello 1981) says, for example, "I feel there are great dangers in the misuse of learning style concepts. Specifically, we must avoid turning these ideas into stereotypes used to pigeonhole individuals. Furthermore, we should not deny students the opportunity to develop themselves fully by only exposing them to educational environments that match their strengths" (p. 373).

This position is supported by Schmeck and associates (1977), who suggest that context influences style and that individuals change their strategies in response to contextual demands, stating this as follows:

> Perhaps the most important style is the metacognitive activity involved in selecting the appropriate strategy for a particular context. I believe that we can facilitate the development of this higher level skill by periodically exposing students to contextual demands that do not precisely match their styles. This must, of course, be done cautiously in order to avoid instilling in the student a feeling of incompetence. However, if we roughly match our instructional technique to the student's style while simultaneously providing experiences in strategies that are outside that style, we may prompt the development of flexibility. This may be a greater service than always structuring the context to match the student's preferred style. (p. 413)

Cross (1976) discusses the problems that research psychologists may have with a simplistic matching schema, questioning the following assumptions: (1) that such a strategy is desirable in terms of student development, (2) that student styles remain constant, and (3) that institutions have infinitely flexible resources. Types of matches suggested by Cross follow:

- **Challenge Match**—a conflict setting in which students are encouraged to develop flexibility and strengthen areas of weakness.
- **Remedial Match**—an uncongenial setting in which students are encouraged to strengthen areas of weakness through remedial instruction.
- **Compensatory Match**—a setting that allows students to compensate for deficiencies in a skill area by using other, more adequately developed skills.

- **Capitalization Match**—a setting designed to capitalize on unique strengths.

The identification of learning styles is apparently a means to the end of matching students to instructional strategies or teaching styles, but not in a simplistic capitalization framework.

There is little doubt that experienced, effective teachers are intuitively using assessment and matching strategies with some success. Through careful observation they note what works and what does not work with each student. Ihlenfeldt (1981) suggests that such trial-and-error analysis takes time:

> All instructors worth their salt have been mapping their students for years, consciously or subconsciously. But this takes six to nine months, and by the time the students' strengths are determined, it may be too late. (p. 100)

The application of treatments through learning styles theory reduces the guesswork involved in this process and heightens students' awareness of their strengths and weaknesses. It also places the expertise of the experienced teacher in the hands of the novice.

Intuitive assessment and matching leaves too great of a margin for error. Cronbach (1967) expresses concern about ad hoc diagnosis of student learning style, offering the following caution:

> The teacher forms an impression of the pupil from the cues, usually without an explicit chain of reasoning. He (or she) proceeds on the basis of impression to alter the instruction; the adaptation, too, is intuitive, without any explicit theory. No doubt the decisions tend to be beneficial, but there is reason to think that intuitive adaptations of this kind will be inefficient and occasionally may be harmful. When we encourage a teacher to adapt in this way to individual differences, we are asking him (or her) to function as a clinician. Clinical procedures are advantageous under certain circumstances. The reading specialist or speech specialist is a clinician who selects from a wide repertoire of instructional methods. But to guide his adaptations, he (or she) has been taught an explicit theory of careful observation. Whereas theories are not available for most school matter, it is very likely that teachers overdifferentiate modifying treatments. Too much produces a worse result than treating everyone alike. (p. 29)

This suggests that intuitive diagnosis and prescription may fail to facilitate the development of flexibility and the metacognitive skills students need in order to select appropriate strategies for their learning.

A second issue that demands careful attention involves the need for a systematic model through which to implement the alternative instructional methodologies indicated by the assessment of learning styles. Such a systematic model is available to practitioners and is known as competency-based vocational education.

Competency-based Vocational Education

The planning of instruction in a highly systematic matter, with attention to the consistency and compatibility of technical knowledge at each point of decision, is known as the "systems approach" (Gagne and Briggs 1974). Training in the use of a systematic approach to instructional design is not necessarily a strength of most vocational instructors (Warner 1981).

Systematic instructional design considers the learner, the learning environment, the content, the technology, learning theory, instruction, and other learning functions. Just as the mastery learning model can benefit from the addition of a systematic approach to providing students with alternative instructional activities to reinforce learning, learning styles theory can benefit from a systematic model through which the program is implemented. Mastery learning can provide that model.

The mastery learning-learning styles combination offers an excellent framework for instruction. The question of what is to be taught, however, remains unanswered. Competency-based instruction, which enables students to focus on a high level of achievement of competencies and tasks drawn from the occupations in which training is being provided, specifies what is to be learned with great exactitude. This instruction is known as competency-based vocational education (CBVE). Hirst (1977) refers to competency-based vocational education as "a systematic approach to instruction, aimed at accountability, based on job-derived standards, and supported by a feedback mechanism" (p. 52). CBVE is also defined operationally. For example, a manual developed by the Florida Department of Education (1976), *Delivering Competency-based Vocational Education*, suggests that CBVE is based upon the following assumptions:

- The skills and knowledges that students learn should be directly related to the duties and responsibilities they will have to perform on the job.
- These skills and areas of knowledge, and the means for evaluating their attainment, should be specified in advance and made known to the students.
- Students should be provided with whatever instructional experiences they need to attain the skills and knowledge required by the jobs they are aiming for. (p. 1)

The manual also notes that as vocational education moves toward a competency-based approach to instruction, it must also move toward individualized instruction. Competency-based vocational education is designed to assist students in acquiring the specific skills and knowledge needed on the job, and since individual students learn differently, instruction must be varied. Providing alternative instructional methodologies to meet individual needs is the essence of individualized instruction.

In order to provide a degree of self-pacing in a CBVE program, instruction is often individualized through the development of learning packages or modules. The design of a learning package involves a systematic approach to instructional design; it takes into account rationale, objectives, learning resources, learning strategies, evaluation, and the physical and emotional setting in which learning is to take place.

Knaak (1981) identifies benefits of CBVE for both educational management and for instruction. Advantages gained for educational management include the following:

- Students are not required to repeat learning of skills and knowledge previously learned.
- Students can obtain immediate access to instructional programs.
- Handicapped students can complete segments of an instructional program which they are able to do, and become job-qualified as a result.
- Handicapped students can obtain immediate access to instructional programs.

- The instructional staff can be used more efficiently.
- The building and instructional equipment can be used more efficiently.
- The placement of graduates in jobs is assisted.
- Students with a wide range of entry-level skills and knowledge can be accepted.
- The instructional content is available twenty-four hours per day for part-time adult students.

Advantages of CBVE for instruction include the following:

- The learner progresses at his or her own best rate to achieve mastery of the instructional content.
- More learners achieve mastery than is possible with group-centered instruction.
- The learner builds confidence by succeeding in learning.
- The students learn to help each other rather than to compete for grades.
- Consistency in presentation of the content is ensured.
- Learners may speed up their personal learning.
- Students can learn more nearly in accord with their preferred learning styles.
- The efficiency of the instructor is increased.
- The instructor performs as a manager of learning—rather than simply as an information giver.

Competency-based vocational education provides for several dimensions of instruction that are outside the domain of learning styles theory. First, learning styles theory is content-independent, whereas CBVE specifies the occupational relevance and evaluation standards required of a vocational-technical curriculum. Second, an individualized system of instruction (provided through the use of individual student modules) provides time variability for students.

Some students accelerate their learning based on ability, prior learning, or experience. Others may acquire mastery of skills and knowledge more slowly because of lack of prerequisite knowledge and skills or rapidity in that mode of learning or content area. This is particularly true of students whose preferred learning style is different from the one for which the instructional methodology provides. Third, CBVE facilitates the accommodation of students' individual learning preferences in the following ways:

- Instructors and curriculum designers can develop modules that provide students with alternate ways of learning the same content.
- Students can vary the use of the modules to fit their own needs.

A module that is designed for one student's individual learning might work equally well with two to four students who decide to work together. This type of peer assistance is encouraged in the system.

The CBVE-learning styles combination is proving to be an effective framework for success-oriented vocational-technical instruction in many settings. A discussion of some of these programs follows.

VOCATIONAL EDUCATION BASED ON LEARNING STYLES

The importance of learning styles theory to education is fundamental and pervasive. Witkin (1973), the father of cognitive style, says, "cognitive style is a potent variable in students' academic choices and vocational preferences; in students' academic development through their school career; in how students' learn and teachers teach; and in how students and teachers interact in the classroom" (p. 11).

This recognition of the importance of learning styles is not, however, universally present among educational practitioners. Kogan (1971) observed in the early 1970s that until the late 1960s, there was an almost total lack of articulation between the psychological study of cognition and educational research and practice. In 1976, Cross noted that "not one teacher or counselor in a hundred knows anything at all about cognitive styles despite the fact that research on cognitive styles has been going on for some twenty-five years in psychology laboratories" (p. 112). This situation has changed only slightly since that time. The research has not been applied widely to educational problems.

The extent of awareness and application of learning styles research to vocational education is probably less even than that in other educational programs. Activities are underway, however, in several vocational-technical schools, and information about some of these programs is being disseminated. Some institutions where programs are in progress include the following:

- 916 Area Vo-Tech Institute, White Bear Lake, Minnesota
- Fox Valley Technical Institute, Appleton, Wisconsin
- Central Nebraska Technical College, Hastings, Nebraska
- Hennepin County Technical Centers, Edina, Minnesota
- Muskingum Area Technical College, Muskingum, Ohio

The programs being implemented at these institutions are based on the educational cognitive style mapping technique developed by Joseph Hill (1981). Hill's mapping model dissects an individual's educational cognitive style into twenty-seven components and groups them into sets.

Basic learning theory states that when introduced to a classroom stimulus, the learner will receive it, perceive or interpret it, draw some conclusions, and react. Mapping is based on the assumption that the learning process can be interrupted by a breakdown in the reception, perception, or decision-making areas. A cognitive style map, in addition to identifying the ways in which individual students can master an educational or vocational task most readily, gives students the self-knowledge essential to direct them to realistic career goals.

Educational cognitive style is not irreversible. New strategies can be acquired. Missing strengths required for a specific occupation can be built on student existing strengths. This is

achieved through the administration and scoring of the educational cognitive style inventory, interpretation of the resulting educational cognitive style map and the accompanying narrative indicating the individual's relative learning strengths, and designing an instructional prescription.

According to Ihlenfeldt (1981), the instructional prescription is of two types for all students:

- The coping aspects—these strategies help the student to succeed. They usually involve altering the instructional methodology to match the student's strengths.

- The development aspects—these strategies help the student to strengthen needed skills. They usually involve providing remedial instruction.

The educational cognitive style mapping prescription attends to the twenty-seven learning and personality components that make up the student's preferred learning style. An example of an educational cognitive style map appears in figure 1.*

The group of nineteen variables in figure 1 designated under the heading "preferences in receiving/transmitting information" assess the perceptual dimension of learning. Use of the five senses is explored along with muscular sensation and such predispositions as empathy, esthetic sense, commitment, body language, structure, and self-understanding.

"Preferences in setting" refers to the social aspect of information processing—that is, whether the individual prefers to interpret information alone, with peers, or with an authority figure. "Preferences in reasoning" also deals with information processing—organizing, differentiating, and relating. In addition, decision-making preferences are assessed. The individual indicates relative preferences (1) in organizing, differentiating, and relating information in decision making and (2) in making decisions deductively.

Whereas the implementation of educational cognitive style mapping differs among the vocational-technical institutions where it is being used, instructors and students are benefiting from the information provided on the twenty-seven components discussed previously. A discussion of two such successful programs follows.

916 Vo-Tech Institute

The 916 Vo-Tech Institute is located in White Bear Lake, Minnesota. Fifty-eight vocational-technical programs are offered for high school and post-high students, as well as numerous adult extension courses and seminars. The instructional system is individualized and competency-based for all instructional programs in an open-entry, time-variable, year 'round system.

The 916 Vo-Tech Institute has used cognitive style mapping since June of 1977. Initially, a pilot project was developed to determine the appropriateness of the concept. The pilot project indicated cognitive style mapping could be beneficial to both students and staff. The program was expanded, on a voluntary basis, to all interested students and instructors. Currently, about 60 percent of the programs are using mapping to some extent. About 50 percent or one thousand five hundred of the students are mapped annually.

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*A learning styles inventory that assesses preferences in receiving/transmitting information and in setting appears in Appendix C.

NEGLI-GIBLE	MINOR	MAJOR	SYMBOL	WITHIN THE CONTEXT OF THE E.C.S. INVENTORY THIS INDIVIDUAL EVALUATED HIMSELF, OR HERSELF, TO BE CURRENTLY:
				PREFERENCES IN RECEIVING/TRANSMITTING INFORMATION
1.		X	T(AL)	* COMFORTABLE WITH RECEIVING INFORMATION THRU SPOKEN WORDS
2.	X		T(AQ)	* LESS COMFORTABLE WITH RECEIVING DATA THRU SPOKEN NUMBERS
3.		X	T(VL)	* COMFORTABLE WITH RECEIVING INFORMATION THRU WRITTEN WORDS
4.		X	T(VQ)	* COMFORTABLE WITH RECEIVING DATA THRU WRITTEN NUMBERS
5.		X	Q(A)	* INCLINED TO USE HIS OR HER SENSE OF HEARING
6.	X		Q(O)	* LESS INCLINED TO USE HIS OR HER SENSE OF SMELL
7.		X	Q(S)	* INCLINED TO USE HIS OR HER SENSE OF TASTE
8.	X		Q(T)	* LESS INCLINED TO USE HIS OR HER SENSE OF TOUCH
9.	X		Q(V)	* LESS INCLINED TO USE HIS OR HER SENSE OF SIGHT
10.		X	Q(P)	* INCLINED TO PERFORM FINE OR GROSS MUSCULATURE TASKS
11.		X	Q(CEM)	* INCLINED TO EMPATHIZE TO GAIN INFORMATION
12.	X		Q(CES)	* LESS INCLINED TO USE BEAUTY OR ORDER TO GAIN INFORMATION
13.		X	Q(CET)	* INCLINED TO BE COMMITTED WHEN GAINING INFORMATION
14.	X		Q(CH)	* LESS INCLINED TO ASSESS ROLE PLAYING TO GAIN INFORMATION
15.	X		Q(CK)	* LESS INCLINED TO USE BODY LANGUAGE TO GAIN INFORMATION
16.		X	Q(CKH)	* INCLINED TO USE PREFERRED FORMAT WHEN GAINING MEANING
17.		X	Q(CP)	* INCLINED TO OBSERVE SOCIAL OR PHYSICAL DISTANCE TO GAIN INFORMATION
18.		X	Q(CS)	* DISPOSED TO UNDERSTANDING ONESELF
19.		X	Q(CT)	* INCLINED TO CONVINCE OTHERS WHEN GAINING INFORMATION
				PREFERENCES IN SETTING
20.		X	I	* LIKELY TO USE AUTHORITY FIGURES IN INTERPRETING INFORMATION
21.	X		A	* LESS LIKELY TO USE PEERS IN INTERPRETING INFORMATION
22.		X	F	* LIKELY TO USE AUTHORITY FIGURES IN INTERPRETING INFORMATION
				PREFERENCES IN REASONING
23.		X	M	* DISPOSED TO MAKE DECISIONS THRU ORGANIZING INFORMATION
24.		X	D	* DISPOSED TO MAKE DECISIONS THRU DIFFERENTIATING INFORMATION
25.	X		R	* LESS DISPOSED TO MAKE DECISIONS THRU RELATING INFORMATION
26.		X	L	* DISPOSED TO MAKE DECISIONS THRU M, D, & R BEHAVIORS
27.		X	(K)	* DISPOSED TO MAKE DECISIONS DEDUCTIVELY

- = NEGLIGIBLE, * = MINOR, * = MAJOR, O = QUESTION(S) OMITTED

	T(AL)*	Q(A)*	Q(P)*	Q(CEM)*			
	T(AQ)*	Q(O)*		Q(CES)*			M*
	T(VL)*	Q(S)*		Q(CET)*		I*	D*
	T(VQ)*	Q(T)*		Q(CH)*			
G =		Q(V)*		Q(CK)*	X	A*	X R*
				Q(CKH)*			
				Q(CP)*		F*	L*
				Q(CS)*			
				Q(CT)*			(K)*

NOTE: See Appendix B for an explanation of the symbols.

Figure 1. Educational Cognitive Style Map

The three major steps in the mapping process are mathematical mapping, empirical mapping, and prescription writing. Mathematical mapping involves the actual testing of the students. The cognitive style mapping inventory used at 916 Vo-Tech is the long form of the Hill inventory, which takes about three and one-half hours to administer. After the students take the various tests, the test results are analyzed and computerized mathematical and narrative maps are printed.

The second phase of the mapping process, empirical mapping, involves the validation of the components of learning style measured on the mathematical maps. During this phase, students are observed by instructors or counselors, are interviewed, or both. Empirical mapping is the most important phase of the process; during this stage the students' maps can be changed or qualified if the empirical findings indicate that the mathematical findings are not completely accurate.

Once the maps have been validated, the third phase of mapping, prescription writing, occurs. At this time, the instructors review the diagnoses (i.e., the maps) and prescribe instructional activities based on the individuals' strengths and weaknesses. The students continue their learning processes guided by their prescriptions.

In the interest of developing staff competence in effectively using educational cognitive style mapping, Warner (1981) used the systems approach to instruction to develop modules for use in providing inservice education for vocational teachers in educational cognitive styles mapping procedures. Eight tasks were identified along with objectives and subobjectives. The tasks, objectives, and subobjectives are listed in exhibit 1.

Fox Valley Technical Institute

All incoming students at Fox Valley Technical Institute in Appleton, Wisconsin, take a three-hour educational cognitive style inventory. Although all students are "mapped," use of the prescriptions by instructors is not required. Currently about 65 percent of the faculty members are voluntarily using the information to individualize and personalize instruction.

A computerized educational cognitive style map and corresponding narrative prescription is mailed to each student along with an invitation to visit with a counselor to discuss the map. Sixty percent of students accept the invitation and spend from one-half to one hour learning about their learning styles. (Fox Valley enrolls about five thousand full-time and thirty-four thousand part-time students. Over six hundred courses in ninety-five occupations are offered).

The maps and prescriptions appear to be about 96 percent accurate, but the prescription is negotiable and may be altered during the validation process. The student's instructor then discusses the map with the student. According to Ihlenfeldt (1981), the map "is easy for the instructor to use, so consequently it is used to help pinpoint the ways in which the student learns best and most easily" (p. 100).

The computerized system used at Fox Valley translates the three functional sets of information about each student's learning preferences into the following alternative instructional methodologies needed to individualize instruction:

- Remedial alternatives (reception)
- Classroom setting alternatives (perception)
- Teaching strategy alternatives (decision making)

Fox Valley began implementing educational cognitive style mapping in 1974. After first attempting to alter instruction at the course level—that is, to package each course in several modes such as classroom instruction, computer-assisted instruction (CAI), and audiovisual tutorial—the institution developed a "burst" approach. In this approach, lecture is presented for a portion of the period, and the group then separates (bursts) into various small groups or into the individualized instruction mode, depending on student needs. Ehlenfeldt (1981) summarizes the experience of Fox Valley Technical Institute with educational cognitive style mapping as follows:

> In summary, cognitive mapping is a practical, effective technique which helps us spot potential learning problems and avoid them; aids in matching students and courses; reduces the dropout rate; and helps improve our students' learning performance overall. (p. 104)

The future of learning styles research and application is clearly promising. For many years educators have recognized the need for alternative instructional methods to meet the needs of the variety of students in our ever more heterogenously grouped classrooms. Mastery learning, implemented through the competency-based vocational education model, sets the stage for the presentation of these alternative instructional methodologies. Learning styles theory provides the means for diagnosis of learning needs and prescription of learning activities. Through this combination of strategies, every student can succeed.

EXHIBIT 1

COMPETENCY-BASED EDUCATIONAL COGNITIVE STYLES TRAINING MODULES

Module One

Task—Explain orally or in writing the importance of recognizing individual learning styles.

Given information on learning theory and learning styles, explain orally, or in writing, the relationship between identification of an individual's learning style and learning with 80 percent accuracy on a written or audio-visual criterion exam.

1. Given learning situations, identify selected principles of learning with 80 percent accuracy on a learning activity.

2. Given definitions and principles of learning theory, explain the concepts of mastery learning with 80 percent accuracy on a learning activity.

3. Given selected diagnosis models and techniques, identify learning style models and techniques, their limitations, and potential applications, with 90 percent accuracy on a learning activity.

4. Given a description of learning style diagnosis, explain how cognitive style mapping relates to learning style diagnosis with 80 percent accuracy on a learning activity.

Module Two

Task—Administer Cognitive Style Mapping Inventory.

Using needed equipment and materials, cognitive style mapping inventory, and a group of individuals, administer the cognitive style mapping inventory with 100 percent accuracy on a performance evaluation instrument.

1. Given an identification of the sections of the cognitive style mapping inventory, explain the purpose of each section with no errors.

2. Provided with a physical setting, arrange a positive testing environment so that it meets 90 percent of the specified criteria.

3. Given a simulated testing situation, explain the procedure for administering the cognitive style mapping inventory with 80 percent accuracy on the activity.

4. Given needed equipment and materials, cognitive style mapping inventory, and a group of individuals, administer the cognitive style mapping inventory so that each individual is able to complete the inventory accurately.

SOURCE: Warner 1981.

EXHIBIT 1, continued

Module Three

Task—Describe orally or in writing mathematical mapping.

Given a cognitive style map, describe, verbally or in writing, mathematical mapping with 80 percent accuracy on a written criterion exam.

1. Given a cognitive style map, identify each major section of the map without any errors.
2. Given a cognitive style map, determine which elements are majors, minors, and negligibles, and explain the implications of each with 100 percent accuracy on a learning activity.
3. Given a cognitive style map, describe each element indicated on the map with 100 percent accuracy.
4. Provided with a cognitive style map, relate the various elements on the map to possible interpretations with 80 percent accuracy.

Module Four

Task—Interpret the mathematical map.

Given a cognitive style map, interpret the mathematical map with 90 percent accuracy on a performance evaluation instrument.

1. Given a cognitive style map and a list with possible interpretations, the student will match the indicated elements with probable interpretations with 90 percent accuracy.
2. Given a cognitive style map and a list of interpretations, match the overall learning style indicated on the map to probable interpretations with 90 percent accuracy.

Module Five

Task—Develop an empirical map.

Given a learner, an interview form, and an observation form, develop an empirical map which meets the criterion of 85 percent accuracy on a performance evaluation instrument.

1. Given a learner and an observation form, observe the learner and complete the observation form so that all relevant data is recorded with 90 percent accuracy on a performance evaluation instrument.
2. Given a learner and an interview form, interview the learner to determine perceptions of his or her educational cognitive style so that all relevant data is recorded.
3. Using the completed observation and interview forms, develop an empirical map for the learner which meets with the learner's approval.

EXHIBIT 1, continued

Module Six

Task—Write a prescription based on mathematical and empirical findings.

Given mathematical and empirical maps and a prescription form, write a prescription based on the findings so that it meets 90 percent of the criteria on a performance evaluation instrument.

1. Provided with mathematical and empirical maps, compare the data on the mathematical map with the empirical findings to meet 90 percent of the criteria on the learning activity.

2. Using the maps and a prescription form, complete the prescription form with no errors on a performance evaluation instrument.

Module Seven

Task—Determine instructional techniques suited to individual learners.

Using a completed prescription form, determine instructional techniques suited to individual learners with 90 percent accuracy on a written criterion exam.

1. Given a simulated situation, identify the relationship of various instructional techniques to elements on the map with 80 percent accuracy on the activity.

2. Given selected learning materials and methods, map the materials and methods with 90 percent accuracy on a performance evaluation instrument.

3. Given a completed prescription form and a list of instructional techniques, determine those techniques suited to an individual learner with 80 percent accuracy on the learning activity.

4. Given a simulated situation, identify how the individual's educational cognitive style could be augmented with 80 percent accuracy on the learning activity.

Module Eight

Task—Implement the prescription with an individual learner.

Given a completed prescription, a learner, and an instructional setting, implement the prescription with an individual learner with 90 percent accuracy on a performance evaluation instrument.

1. Provided with a completed prescription and a learner, present the prescription to the learner indicating how that individual's educational cognitive style will be complemented with 80 percent accuracy on a performance checklist.

2. Using a completed prescription, a learner, and teaching materials, apply appropriate teaching techniques and instructional materials in a simulated teaching situation with 80 percent accuracy on a performance checklist.

APPENDIX A

LEARNING STYLES RESOURCES

LEARNING STYLES RESOURCES

Center for Applications of Psychological Type, Inc. (CAPT)
414 Southwest 7th Terrace
Gainesville, Florida 32601
Telephone: (904) 375-0160
Contact: Mary McCaulley or Richard Kainz, Research
Jamelyn Johnson, Publications
Pamela Amend, Computer Scoring Service

The Center for Applications of Psychological Type is concerned with the constructive use of information about individual differences in teaching and learning, in the workplace, and in families. It was established to provide a center for research on the theories of C. G. Jung—particularly those related to psychological type. Much of this research is related to the "Myers-Briggs Type Indicator" (MBTI), a forced-choice questionnaire that assesses preferred ways of functioning. The MBTI is made available to qualified professionals in counseling and psychological services to administer and interpret.

CAPT provides research, training, publications, and computerized scoring services for the MBTI. Lists of publications and MBTI materials are available from the Center, along with a newsletter, "CAPT Update," which is distributed at no cost several times yearly.

People Types and Tiger Stripes: A Practical Guide to Learning Styles by Gordon D. Lawrence ($4.50) is published by CAPT. This book explains how psychological type may be observed in teaching and learning, and contains strategies for encouraging individuals' learning types through activities.

Center for Cognitive Studies (CCS)
P.O. Box 5118
Essex Junction, Vermont 05453
Telephone: (802) 656-3356
Contact: Charles Letteri, Director

The Center for Cognitive Studies was established for the purpose of assessing, analyzing, and augumenting individual cognitive functioning. Based on the assessment of seven dimensions of cognition, augumentation procedures are designed to correct deficits.

A kit, including three forms of reusable cognitive assessment instruments (Kindergarten, Primary, and Adolescent-Adult) and manuals instructing users in administration of the instruments as well as construction and analysis of cognitive profiles, is available for $250.00. *The Manual for Augmentation Strategies* by Charles Letteri will be available in late 1982. Copies of various other publications related to the Center's activities are available upon request.

Association for Supervision and Curriculum Development (ASCD)
225 North Washington Street
Alexandria, Virginia 22314
Telephone: (703) 549-9110
Contact: Ruth Long, Associate Director

The Association for Supervision and Curriculum Development seeks balanced programs for assuring equal and quality educational opportunities for all students through the identification, study, and evaluation of issues in supervision, curriculum, and instruction. The Association provides human resource development experiences in curriculum planning and development, supervisory skill, and leader behavior through: (1) annual conferences; (2) National Curriculum Study Institutes; (3) a variety of publications, including the professional journal, *Education Leadership*; (4) audio- and videocassette tapes for staff development purposes; and (5) a Research Information Service.

Several National Curriculum Study Institutes on learning styles are offered each year by ASCD. Available from the organization on videotape or film is a presentation narrated by Rita Dunn, called, "Learning—A Matter of Style." The videotape may be purchased by ASCD members for $195.00. The price for nonmembers is $230.00. The film is $295.00 ($330.00 for nonmembers). The videotape may be rented for $45.00 (5 days) or previewed for $20.00 (2 days). Rental or preview fees may be credited toward the purchase price.

An audiotape entitled "Recent Research on Learning Styles and Practical Implications for Supervisors and Teachers," narrated by Rita and Kenneth Dunn, is available for $9.00. The stock number is 612-20232.

Center for the Study of Learning and Teaching Styles (CSLTS)
School of Education and Human Services
St. John's University
Grand Central Parkway
Jamaica, New York 11439
Telephone: (212) 969-8000, Ext. 6335 or 6336
Contact: Rita Dunn, Project Director

The Center for the Study of Learning and Teaching Styles focuses its research on identifying the learning styles of individual students, as well as the teaching styles of individual teachers, and matching these teaching and learning styles. In addition, efforts are being made to design and use instructional strategies to respond to varied learning styles, to develop techniques for organizing and administering an educational program based on learning and teaching styles, and to develop instructional resources appropriate to instruction based on learning styles.

Numerous articles have been published by project director Rita Dunn and her associates, and a book has been coauthored by Rita and Kenneth Dunn. The book, *Teaching Students Through Their Individual Learning Styles*, is available from Reston Publishing, Division of Prentice-Hall, Reston, Virginia 22091. The cost of the publication is $18.95.

Two instruments for assessing learning styles were developed by Rita and Kenneth Dunn with Gary Price. The instrument designed for use with students is called the "Learning Style Inventory" (LSI). A specimen set, including an informational brochure, a sample LSI, samples of the two answer sheets available (one for use in grades three through five and one for use in grades six through twelve), an instructor's manual, and a research report, may be obtained for $10.00 from Price Systems, Inc., P.O. Box 3067, Lawrence, Kansas 66044.

The assessment instrument designed for use with adults is called the "Productivity Environmental Preference Survey" (PEPS). A specimen set, including a sample PEPS booklet, a manual, and an answer sheet, may be obtained from Price Systems for $8.00.

Lifelong Learning and Adult Development Project (LLLAD)
Weatherhead School of Management
Case Western Reserve University
Cleveland, Ohio 44106
Telephone: (216) 368-2137
Contact: Marian Hogue, Project Coordinator

The Lifelong Learning and Adult Development Project at Case Western Reserve University is a research project concerned with the development of experiential learning theory and its applications to education, career development, and organizational effectiveness.

An NIE-funded study completed by the LLLAD project is reported in *Professional Education and Career Development: A Cross Sectional Study of Adaptive Competencies in Experiential Learning*, by David A. Kolb and others. The report is available on microfiche only from the ERIC Document Reproduction Service (order number ED 209 493; price $1.44), P.O. Box 190, Arlington, Virginia, 22210.

The purpose of this project was to study the relationship between professional education and the world of work, in the context of a lifelong learning process. The theoretical framework used was experiential learning theory, which conceptualizes learning in such a way that differences in individual learning styles and corresponding learning environments can be identified.

Two instruments are available for assessing learning styles, the "Learning Style Inventory" (LSI) and "The Adaptive Style Inventory" (ASI).

LLLAD has published numerous chapters and articles about the experiential learning cycle and the learning styles defined through it. A bibliography listing these publications is available from the project, along with research studies on experiential learning theory and the LSI.

National Association of Secondary School Principals (NASSP)
1904 Association Drive
Reston, Virginia 22091
Telephone: (703) 860-0200
Contact: James W. Keefe, Director of Research

The National Association of Secondary School Principals is committed to the improvement of secondary education through informational and leadership activities, research, and service. The organization provides a broad range of programs, including workshops on learning styles.

Among the many publications available from NASSP are two on the topic of learning styles. A monograph reporting on learning styles research and applications, entitled *Student Learning Styles: Diagnosing and Prescribing Programs* was edited by James W. Keefe, and may be obtained for $5.00 (Stock No. 2107936). *Selected Learning Styles Instrumentation: An Annotated Bibliography*, which lists readily available, validated inventories to be used in assessing student learning styles, may be obtained for $1.00.

National Network on Learning Styles (NNLS)
School of Education and Human Services
St. John's University
Grand Central Parkway
Jamaica, New York 11439
Telephone: (212) 969-8000, Ext. 6335 or 6336
Contact: Rita Dunn, Project Director

The National Network on Learning Styles is cosponsored by the National Association of Secondary School Principals and St. John's University. The organization publishes the *Learning Styles Network Newsletter*. The newsletter, which is issued three times yearly, reports the latest information on all facets of learning styles theory and practice, and serves as a vehicle for information exchange. It features (1) reviews of articles and books; (2) reports on exemplary programs; and (3) lists of conferences, institutes, and inservice workshops on learning styles. Interested persons can receive the newsletter by becoming a member of the National Network on Learning Styles. Membership dues are $10.00 per year.

A bibliography on learning styles is available from the NNLS for $5.00, along with a Programmed Learning Sequence (PLS). The PLS (available for $8.00) explains how to help individuals learn more easily by introducing new information or skills through each individual's strongest modality, and reinforcing them through other modalities.

The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210
Telephone: (614) 486-3655
Contacts: Program Information Office or National Center Publications

The National Center for Research in Vocational Education endeavors to aid a variety of organizations in their efforts to solve educational problems relating to individual career planning, preparation, and progression. A large number of projects are focused on improving educational programs for both youth and adults.

Several projects related to learning styles are underway, and a monograph that reviews cognitive and learning style literature—the product of one such project—is available from National Center Publications. This publication, *Cognitive Style, Learning Style, and Transfer Skill Acquisition* by Patricia Kirby, may be obtained for $7.25. The order number is IN 195.

APPENDIX B

SUMMARY OF THE EDUCATIONAL SCIENCES SYMBOLS AND THEIR MEANINGS

SUMMARY OF THE EDUCATIONAL SCIENCES SYMBOLS AND THEIR MEANINGS

Two types of symbols, theoretical (e.g., words and numbers) and qualitative (e.g., sensory, programmatic, and codes), are created and used by individuals to acquire knowledge and derive meaning from their environments and personal experiences. Theoretical symbols present to the nervous system, and then represent to it something different from that which they themselves are. For example, the spoken word "cup" is an auditory sensation which represents to the individual hearing it the physical object of a cup. Since this auditory sensation (the sound "cup") presents to the individual's nervous system something different from that which it (the symbol) itself is, it is called a "theoretical auditory linguistic symbol." In the visual dimension, the imagery resulting from the individual's observing the printed word "cup", which would present to the awareness of the individual the same physical object that the word "cup" would produce, is an example of theoretical visual linguistic symbolic mediation.

Qualitative symbols present and then represent to the nervous system of the individual that which they (the symbols) themselves are to that individual. Meanings for qualitative symbols are derived from three sources: (1) sensory stimuli; (2) cultural codes (games); and (3) programmatic effects of objects which convey an almost automatic impression of a definite series of images, scenes, events, or operations. At the present time, there are 25 qualitative symbols included in the "symbolic" set; five of them associated with sensory stimuli, ten that are programmatic in nature, and ten associated with cultural codes.

There are two main types of theoretical symbols—auditory and visual—each of which can be divided into linguistic and quantitative elements. The four theoretical symbols are defined as follows:

T(VL) Theoretical Visual Linguistics—ability to find meaning from words you see. A major in this area indicates someone who reads with a better than average degree of comprehension.

T(AL) Theoretical Auditory Linguistics—ability to acquire meaning through hearing spoken words.

T(VQ) Theoretical Visual Quantitative—ability to acquire meaning in terms of numerical symbols, relationships, and measurements.

T(AQ) Theoretical Auditory Quantitative—ability to find meaning in terms of numerical symbols, relationships, and measurements that are spoken.

The five qualitative symbols associated with sensory stimuli are as follows:

Q(A) Qualitative Auditory—ability to perceive meaning through the sense of hearing. A major in this area indicates ability to distinguish between sounds, tones of music, and other purely sonic sensations.

SOURCE: Hill 1981.

Q(O) Qualitative Olfactory—ability to perceive meaning through the sense of smell.

Q(S) Qualitative Savory—ability to perceive meaning by the sense of taste. Chefs should have highly developed qualitative olfactory and savory abilities.

Q(T) Qualitative Tactile—ability to perceive meaning by the sense of touch, temperature, and pain.

Q(V) Qualitative Visual—ability to perceive meaning through sight.

The qualitative symbols that are programmatic in nature are as follows:

Q(PF) Qualitative Proprioceptive (Fine)—ability to synthesize a number of symbolic mediations into a performance demanding monitoring of a complex task involving small, or fine, musculature (e.g., playing a musical instrument, typewriting); or into an immediate awareness of a possible set of interrelationships between symbolic mediations, i.e., dealing with "signs." While qualitative proprioceptive fine symbolic intelligence is most readily observable in seemingly automatic motor responses such as reading and playing music, certain types of theoretical symbolic mediation also require qualitative proprioceptive activity. For example, the synthesis of a number of symbolic mediations is evident when an individual, upon seeing a sign of smoke, immediately interprets it as evidence of fire and experiences an interplay of many sensations, including smell of smoke, taste of smoke, and sensation of heat. In this instance a network of previous experiences and related associations produces the theoretical mediation of fire along with the other qualitative aspects.

Q(PG) Qualitative Proprioceptive (Gross)—ability to synthesize a number of symbolic mediations into a performance demanding monitoring of a complex task involving large, or gross, musculature (e.g., throwing a baseball, or skiing).

Q(PDF) Qualitative Proprioceptive Dextral (Fine)—a predominance of right-eyed, right-handed and right-footed tendencies (a typically right-handed person) while synthesizing a number of symbolic mediations into a performance demanding monitoring of a complex task involving small, or fine, musculature (e.g., writing right-handed).

Q(PDG) Qualitative Proprioceptive Dextral (Gross)—a predominance of right-eyed, right-handed and right-footed tendencies (a typically right-handed person) while synthesizing a number of symbolic mediations into a performance demanding monitoring of a complex task involving large, or gross, musculature (e.g., throwing a baseball with the right hand.)

Q(PKF) Qualitative Proprioceptive Kinematics (Fine)—ability to synthesize a number of symbolic mediations into a performance demanding the use of fine musculature while monitoring a complex physical activity involving motion.

Q(PKG) Qualitative Proprioceptive Kinematics (Gross)—ability to synthesize a number of symbolic mediations into a performance demanding the use of gross musculature while monitoring a complex physical activity involving motion.

Q(PSF) Qualitative Proprioceptive Sinistral (Fine)—a predominance of left-eyed, left-handed and left-footed tendencies (a typically left-handed person) while synthesizing a number of symbolic mediations into a performance demanding monitoring of a complex task involving small, or fine, musculature (e.g., writing left-handed).

Q(PTF) Qualitative Proprioceptive Temporal (Fine)—ability to synthesize a number of symbolic mediations into a performance demanding the use of fine musculature while monitoring a complex physical activity involving timing.

The remaining ten qualitative symbols associated with cultural codes are defined as:

Q(CEM) Qualitative Code Empathic—the capacity to derive meaning through sensitivity to the feelings of others; ability to put yourself in another person's place and see things from that person's point of view.

Q(CES) Qualitative Code Esthetic—capacity to enjoy the beauty of an object or an idea. Beauty in surroundings or a well-turned phrase are appreciated by a person possessing a major strength in the area.

Q(CET) Qualitative Code Ethic—commitment to a set of values, a group of principles, obligations and/or duties. This commitment need not imply morality. Both a priest and a criminal may be committed to a set of values although the "values" may be decidedly different.

Q(CH) Qualitative Code Histrionic—capacity to exhibit a deliberate behavior, or play a role to produce some particular effect on other persons. This type of person knows how to fulfill role expectations.

Q(CK) Qualitative Code Kinesics—capacity to understand, and to communicate by, nonlinguistic functions such as facial expressions and motions of the body (e.g., smiles and gestures).

Q(CKH) Qualitative Code Kinesthetic—capacity to perform motor skills, or effect muscular coordination according to a recommended, or acceptable, form (e.g., bowling according to form, or golfing).

Q(CP) Qualitative Code Proxemics—capacity to judge the physical and social distance that the other person would permit, between oneself and that other person.

Q(CS) Qualitative Code Synnoetics—capacity to have personal knowledge of oneself.

Q(CT) Qualitative Code Transactional—capacity to maintain a positive communicative interaction which significantly influences the goals of the persons involved in that interaction.

Q(CTM) Qualitative Code Temporal—capacity to respond or behave according to time expectations imposed on an activity by members in the role-set associated with that activity.

Cultural Determinants

There are three cultural determinants of the meaning of symbols: (1) individuality (I), (2) associates (A), and (3) family (F). It is through these "determinants" that cultural influences are brought to bear by the individual on the meanings of symbols. The "individuality" influence is frequently reflected by the individual's need to quote definitions, or explain situations, in his or her own words. The "associates" influence is frequently evidenced by an individual who

understands that which is under consideration, but explains or discusses these matters mainly in the words of his associates who may be involved with him or her in the situation. The "family" determinant is frequently portrayed by the individual possessing it through examples one may use in explaining a situation or solving a problem (e.g., either parents, children, wife, husband, sibling, cousin, close friend, etc., are used to illustrate a situation analogous to the one under consideration).

Modalities of Inference

The third set of the Cartesian product indicating cognitive style includes elements which indicate the individual's modality of inference, i.e., the form of inference one tends to use:

M Magnitude—a form of "categorical reasoning" that utilizes norms or categorical classifications as the basis for accepting or rejecting an advanced hypothesis. Persons who need to define things in order to understand them reflect this modality.

D Difference—this pattern suggests a tendency to reason in terms of one-to-one contrasts or comparisons of selected characteristics or measurements. Artists often possess this modality as do creative writers and musicians.

R Relationship—this modality indicates the ability to synthesize a number of dimensions or incidents into a unified meaning, or through analysis of a situation to discover its component parts. Psychiatrists frequently employ the modality of relationship in the process of psychoanalyzing a client.

L Appraisal—is the modality of inference employed by an individual who uses all three of the modalities noted above (M, D, and R), giving equal weight to each in his reasoning process. Individuals who employ this modality tend to analyze, question, or, in effect, appraise that which is under consideration in the process of drawing a probability conclusion.

K Deductive—indicates deductive reasoning, or the form of logical proof used in geometry or that employed in syllogistic reasoning.

APPENDIX C

LEARNING STYLES INVENTORY

DIRECTIONS FOR ADMINISTERING THE LEARNING STYLES INVENTORY (Instructor)

1. Distribute forms and pencils. Check to see that the students write their names on the answer sheet.

2. Read the directions on the page titled "Learning Styles Inventory Instructions" (p. 59) to the students. Indicate that you will read each statement to them as they read it to themselves and that you will give them opportunities to ask questions throughout the inventory. Emphasize that the first response that they think of is usually the best one.

3. Give the students an opportunity to ask questions.

4. Read the sample statement to the students and allow about ten to fifteen seconds for them to respond.

5. Discuss the sample statement and answer students' questions.

6. Read each statement to the students, allowing ten to fifteen seconds for them to respond.

7. Give the students specific opportunities to ask questions again after the third statement and at the conclusion of the inventory.

8. At the conclusion of the inventory check to see that the students have marked one response for each statement.

9. If the students are to score their own inventories, proceed to the directions for scoring.

Scoring

1. Direct the students to turn to the Learning Styles Inventory Worksheet (p. 63).

2. Write the following example on the chalk board. (A sample Learning Styles Inventory Worksheet appears on page 55).

SOURCE: Adapted from the Learning Styles Inventory developed by Murdock Teacher Center, Wichita, Kansas.

VISUAL LANGUAGE

5	3
13	4
21	4
29	3
37	4

Total 18 × 2 = 36 (Score)

3. Explain that these are the scores from a sample answer sheet for items 5, 13, 21, 29, and 37 on the inventory and that these scores reveal relative preferences for visual learning.

4. Give students an opportunity to ask questions.

5. Direct the students to do as follows:

   a. Find the number of the response selected for each statement and write it in the blank provided for that statement number on the Learning Styles Inventory Worksheet (p. 63).

   b. Total the numbers under each heading.

   c. Multiply the total by two (2).

   d. Place an X on the Learning Styles Profile (p. 64) above the total score for each of the nine headings. (A sample Learning Styles Profile appears on page 56.)

6. Use the descriptions on the page titled "Descriptions of Learning Styles" (p. 57) to assist students in understanding their learning styles.

LEARNING STYLES INVENTORY WORKSHEET

(SAMPLE)

1. VISUAL LANGUAGE

5	3
13	4
21	4
29	3
37	4

Total 18 x 2 = 36 (Score)

2. VISUAL NUMERICAL

9	4
17	2
25	4
33	4
41	3

Total 17 x 2 = 34 (Score)

3. AUDITORY LANGUAGE

3	2
11	3
19	3
36	2
44	3

Total 13 x 2 = 26 (Score)

4. AUDITORY NUMERICAL

7	2
15	3
23	2
31	2
39	1

Total 10 x 2 = 20 (Score)

5. AUDITORY-VISUAL-KINESTHETIC (Combination)

1	4
18	3
26	3
34	3
42	4

Total 17 x 2 = 34 (Score)

6. INDIVIDUAL LEARNER

4	4
12	2
20	2
28	4
45	4

Total 16 x 2 = 32 (Score)

7. GROUP LEARNER

8	3
16	1
24	2
32	2
40	3

Total 11 x 2 = 22 (Score)

8. EXPRESSIVENESS-ORAL

6	3
14	3
22	3
30	3
38	3

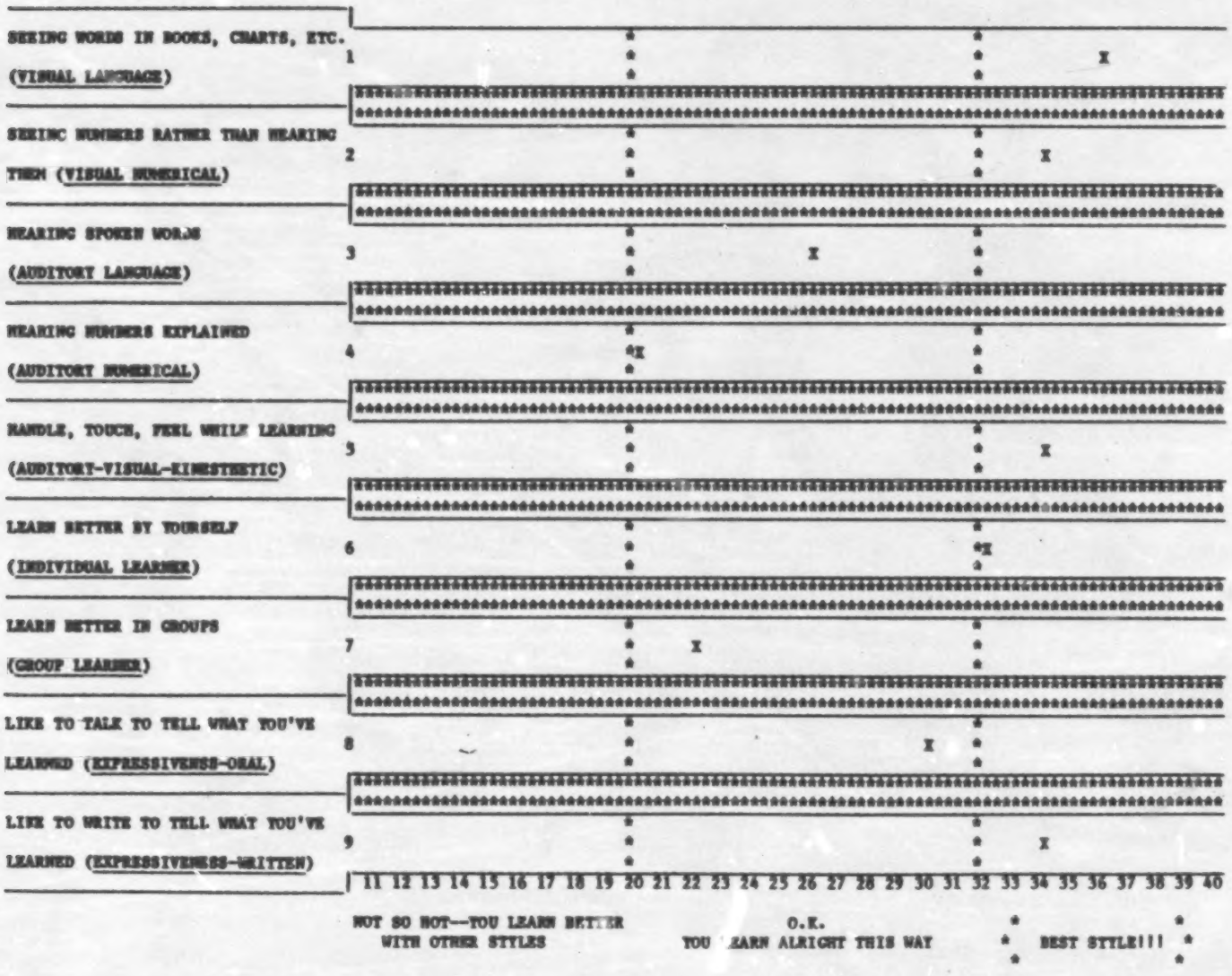
Total 15 x 2 = 30 (Score)

9. EXPRESSIVENESS-WRITTEN

2	4
10	3
27	2
35	4
43	4

Total 17 x 2 = 34 (Score)

LEARNING STYLES PROFILE
(Sample)


SEEING WORDS IN BOOKS, CHARTS, ETC. (VISUAL LANGUAGE)
SEEING NUMBERS RATHER THAN HEARING THEM (VISUAL NUMERICAL)
HEARING SPOKEN WORDS (AUDITORY LANGUAGE)
HEARING NUMBERS EXPLAINED (AUDITORY NUMERICAL)
HANDLE, TOUCH, FEEL WHILE LEARNING (AUDITORY-VISUAL-KINESTHETIC)
LEARN BETTER BY YOURSELF (INDIVIDUAL LEARNER)
LEARN BETTER IN GROUPS (GROUP LEARNER)
LIKE TO TALK TO TELL WHAT YOU'VE LEARNED (EXPRESSIVENESS-ORAL)
LIKE TO WRITE TO TELL WHAT YOU'VE LEARNED (EXPRESSIVENESS-WRITTEN)
1
2
3
4
5
6
7
8
9
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
NOT SO HOT--YOU LEARN BETTER WITH OTHER STYLES
O.K. YOU LEARN ALRIGHT THIS WAY
BEST STYLE!!!

50

INSTRUCTOR

DESCRIPTIONS OF LEARNING STYLES

The Learning Styles Inventory is divided into three main areas: information gathering/receiving (learning), social work conditions (working), and expressiveness (reporting).

Scores on the Learning Styles Inventory fall into one of three categories: major, minor, and negligible. These categories are interpreted as follows:

- *Major:* The student prefers this mode of learning, feels comfortable with it, and uses it for important (to the student) learning. (A student does not necessarily have one and only one preferred style.)

- *Minor:* The student uses this mode, but usually as a second choice or in conjunction with other learning styles.

- *Negligible:* The student prefers not to use this mode if other choices are available, and does not feel comfortable with it.

The following are descriptions of learning styles that can be found in every learner to a major, minor, or negligible extent. These descriptions provide information for use in validating students' learning styles on the basis of observation. The Learning Styles Inventory is a tool that facilitates the evaluation of these learning styles. Each of the style areas is described for major scores.

In the area of learning, the Learning Styles Inventory investigates five areas. They are as follows:

1. *Visual Language.* Students who demonstrate this preference learn best by seeing words in books, on the chalkboard, in charts, or in workbooks. They tend to write down words that they hear in order to learn by seeing them on paper. They remember and use information best that they read.

2. *Visual Numerical.* Students who demonstrate this preference need to see numbers in order to work with them. They tend to remember and understand math facts if they have seen them. They don't seem to need much oral explanation.

3. *Auditory Language.* Students who demonstrate this preference learn from hearing words spoken. They may vocalize (or subvocalize) as they read, particularly when attempting to understand new material. They understand and remember best facts they have learned by hearing.

4. *Auditory Numerical.* Students who demonstrate this preference learn from hearing numbers and explanations. They may remember phone and locker numbers with ease, and be successful with oral numbers, games, and puzzles. They may do just about as well without a math book as with one, because written materials are not important to them. They probably work problems in their heads. They may say numbers to themselves as they read problems.

5. *Auditory-Visual-Kinesthetic Combination.* A-V-K students learn best through experience. They need a combination of stimuli. The manipulation of material along with the accompanying sight and sounds (words and numbers seen and spoken) make a big difference in their learning. They may not seem to be able to understand assignments, or be able to keep their minds on their work unless they are totally involved. They attempt to handle, touch, and work with what they are learning.

The area of working considers whether students like to work or learn in a group or alone. Areas investigated are as follows:

6. *Individual Learner.* Students who demonstrate this preference get more work done by themselves. They think best, and remember more when they learn alone. They care more for their own opinions than for the ideas of others.

7. *Group Learner.* Students who demonstrate this preference strive to study with at least one other student, and do not get much done studying alone. They value others' opinions and preferences. Group interaction increases their learning and later recognition of facts. Socializing is important to them.

The area of reporting considers how students prefer to express themselves. Style preferences fall into one of the following categories:

8. *Oral Expressive.* Students who demonstrate this preference can easily tell what they know. They talk fluently and comfortably and seem to be able to say what they mean. They probably know more than their written tests show. They are not shy about giving reports or talking to teachers or classmates. Organizing and putting thoughts on paper, however, may be difficult for these students.

9. *Written Expressive.* Students who demonstrate this preference write essays and answers to test questions easily. They are uncomfortable giving answers orally. Their thoughts are better organized when written than when given orally.

LEARNING STYLES INVENTORY INSTRUCTIONS
(Student)

Read each statement carefully and decide which of the four responses agrees with how you feel about the statement. Put an X on the number of your response on the answer sheet.

Sample statement

I would rather do schoolwork in the morning than in the afternoon.

On the answer sheet, there are four possible responses ranging from "MOST LIKE ME" to "LEAST LIKE ME." Decide which response best describes the way you feel about a statement and put an X on that number in the parenthesis. Respond to the sample statement here by marking the one response that best describes your feelings.

	MOST LIKE ME	LEAST LIKE ME
1.	(4) (3)	(2) (1)

Explanation of Responses

If you are the sort of person who rises early and enjoys working before noon, you would probably respond by putting an X on the (4). If you start slowly and usually begin to work better later in the day, you probably would respond by marking the (1). If you are somewhere in between, then your response should be a (3) or a (2) depending on where you think you fit.

You cannot make a mistake because there is no right or wrong answer. Only the way you feel about the statement is correct. There are 45 statements on the two pages. Please choose an answer for each statement and mark your answers on the answer sheet the same way you did for the sample statement. You may have all the time you want, so please respond to every statement.

Now, if there are no questions, go to the page titled "Learning Styles Inventory" (p. 60) and begin. Be sure you respond only once to each statement, but be sure you respond to every statement. Mark only on the answer sheet so the other pages can be used again. Thank You.

STUDENT

LEARNING STYLES INVENTORY

Questions

1. When I make things for my studies, I remember what I have learned better.
2. Written assignments are easy for me to do.
3. I learn better if someone reads a book to me than if I read silently to myself.
4. I get more done when I work alone.
5. I remember what I have read better than what I've heard.
6. When I answer questions, I can say the answer better than I can write it.
7. When I do math problems in my head, I say the numbers to myself.
8. If I need help in a subject, I will ask a classmate for help.
9. I understand a math problem that is written better than one I hear.
10. I don't mind doing written assignments.
11. I remember things I hear better than the things I read.
12. I like to work by myself.
13. I would rather read a story than listen to it read.
14. I would rather show and explain how a thing works than write about how it works.
15. Saying the multiplication tables over and over helped me to remember them better than writing them over and over.
16. I like to work in a group because I learn from the others in my group.
17. When the teacher says a number, I really don't understand it until I see it written down.
18. Writing a spelling word several times helps me remember it better.
19. I find it easier to remember what I have heard than what I have read.
20. I learn best when I study alone.
21. When I have a choice between listening or reading, I usually read.
22. I feel like I talk "smarter" than I write.
23. When I'm told the pages of my homework, I can remember them without writing them down.
24. I get more work done when I work with someone.
25. Written math problems are easier for me to solve than spoken ones.
26. I like to do things with my hands, like simple repairs or crafts.
27. The things I write on paper sound better when I say them.
28. I study best when no one is around to talk or listen to.
29. I do well in classes where most of the information has to be read.
30. If homework were oral, I would do it all.
31. When I have a written math problem to do, I say it to myself to understand it better.
32. I can learn more about a subject if I am with a small group of students.
33. Seeing a number makes more sense to me than hearing a number.
34. I like to make things with my hands.
35. I like tests that ask me to complete a sentence or write down the answers.
36. I understand more from a class discussion than from reading about a subject.
37. I learn better by reading than by listening.
38. I would rather tell a story than write it.
39. It makes it easier to work out a math problem when I say the numbers to myself.
40. I like to study with other people.
41. Seeing the price of something written down is easier for me to understand than having someone tell me the price.

42. I understand what I have learned better when I am involved in making something for the assignment.
43. The things I write down on paper sound better than when I talk about them.
44. I do well on tests if they are about things I hear in class.
45. I can't think as well when I work with someone else as when I work alone.

STUDENT

LEARNING STYLES INVENTORY
ANSWER SHEET

	MOST LIKE ME	LEAST LIKE ME		MOST LIKE ME	LEAST LIKE ME		MOST LIKE ME	LEAST LIKE ME
1.	(4) (3)	(2) (1)	16.	(4) (3)	(2) (1)	31.	(4) (3)	(2) (1)
2.	(4) (3)	(2) (1)	17.	(4) (3)	(2) (1)	32.	(4) (3)	(2) (1)
3.	(4) (3)	(2) (1)	18.	(4) (3)	(2) (1)	33.	(4) (3)	(2) (1)
4.	(4) (3)	(2) (1)	19.	(4) (3)	(2) (1)	34.	(4) (3)	(2) (1)
5.	(4) (3)	(2) (1)	20.	(4) (3)	(2) (1)	35.	(4) (3)	(2) (1)
6.	(4) (3)	(2) (1)	21.	(4) (3)	(2) (1)	36.	(4) (3)	(2) (1)
7.	(4) (3)	(2) (1)	22.	(4) (3)	(2) (1)	37.	(4) (3)	(2) (1)
8.	(4) (3)	(2) (1)	23.	(4) (3)	(2) (1)	38.	(4) (3)	(2) (1)
9.	(4) (3)	(2) (1)	24.	(4) (3)	(2) (1)	39.	(4) (3)	(2) (1)
10.	(4) (3)	(2) (1)	25.	(4) (3)	(2) (1)	40.	(4) (3)	(2) (1)
11.	(4) (3)	(2) (1)	26.	(4) (3)	(2) (1)	41.	(4) (3)	(2) (1)
12.	(4) (3)	(2) (1)	27.	(4) (3)	(2) (1)	42.	(4) (3)	(2) (1)
13.	(4) (3)	(2) (1)	28.	(4) (3)	(2) (1)	43.	(4) (3)	(2) (1)
14.	(4) (3)	(2) (1)	29.	(4) (3)	(2) (1)	44.	(4) (3)	(2) (1)
15.	(4) (3)	(2) (1)	30.	(4) (3)	(2) (1)	45.	(4) (3)	(2) (1)

Name _____ School _____ Grade _____ Date _____

LEARNING STYLES INVENTORY WORKSHEET

Name _____ Date _____

1. VISUAL LANGUAGE

5 ___
13 ___
21 ___
29 ___
37 ___

Total _____ x 2 = ___ (Score)

2. VISUAL NUMERICAL

9 ___
17 ___
25 ___
33 ___
41 ___

Total _____ x 2 = ____(Score)

3. AUDITORY LANGUAGE

3 ___
11 ___
19 ___
36 ___
44 ___

Total_____ x 2 = ____ (Score)

4. AUDITORY NUMERICAL

7 ___
15 ___
23 ___
31 ___
39 ___

Total _____ x 2 = _____(Score)

5. AUDITORY-VISUAL-KINESTHETIC (Combination)

1 ___
18 ___
26 ___
34 ___
42 ___

Total _____ x 2 = _____(Score)

6. INDIVIDUAL LEARNER

4 ___
12 ___
20 ___
28 ___
45 ___

Total_____ x 2 = ____ (Score)

7. GROUP LEARNER

8 ___
16 ___
24 ___
32 ___
40 ___

Total _____ x 2 = ____ (Score)

8. EXPRESSIVENESS-ORAL

6 ___
14 ___
22 ___
30 ___
38 ___

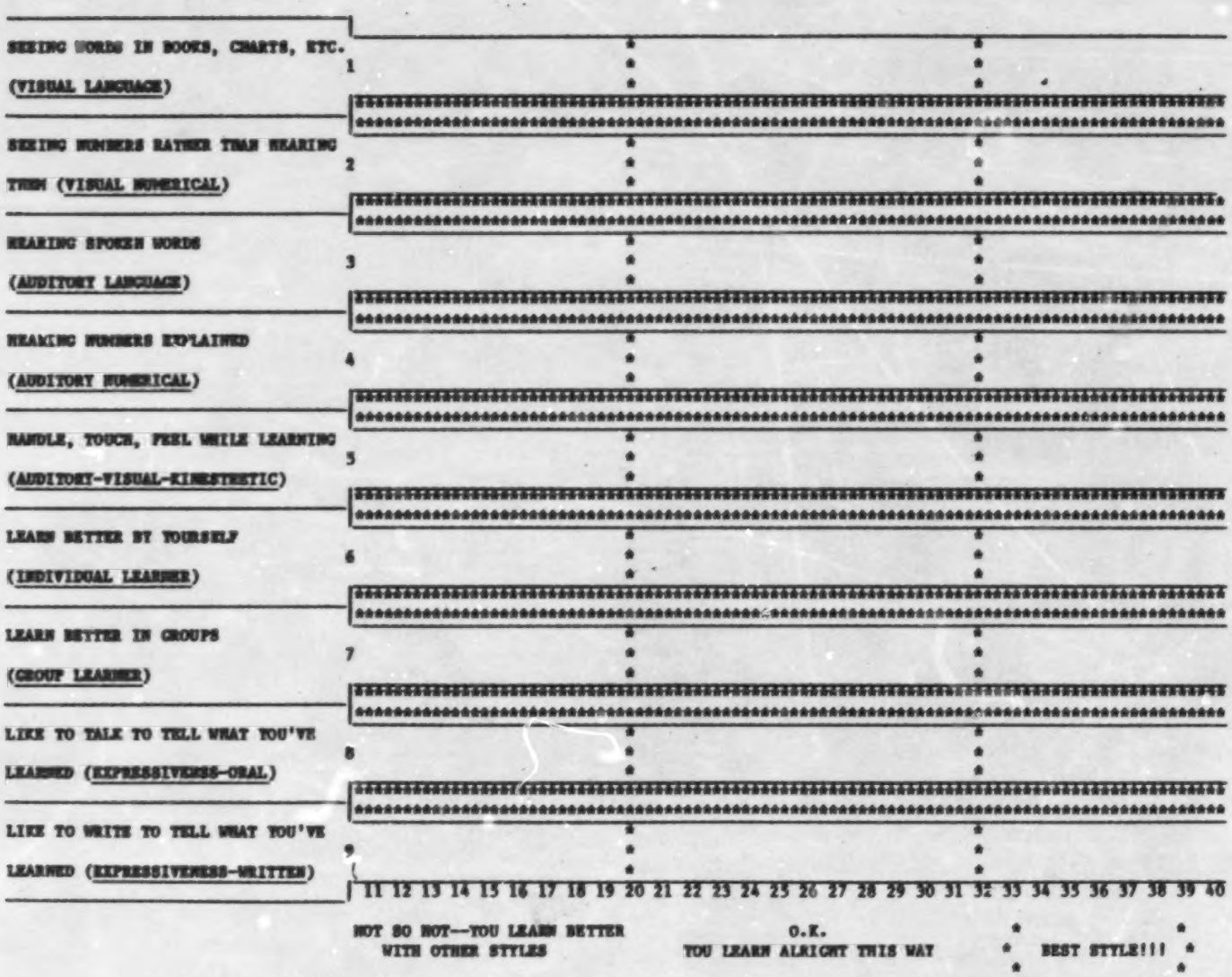
Total _____ x 2 = _____(Score)

9. EXPRESSIVENESS-WRITTEN

2 ___
10 ___
27 ___
35 ___
43 ___

Total_____ x 2 = _____(Score)

LEARNING STYLES PROFILE


SEEING WORDS IN BOOKS, CHARTS, ETC. (VISUAL LANGUAGE)
1
SEEING NUMBERS RATHER THAN HEARING THEM (VISUAL NUMERICAL)
2
HEARING SPOKEN WORDS (AUDITORY LANGUAGE)
3
HEARING NUMBERS EXPLAINED (AUDITORY NUMERICAL)
4
HANDLE, TOUCH, FEEL WHILE LEARNING (AUDITORY-VISUAL-KINESTHETIC)
5
LEARN BETTER BY YOURSELF (INDIVIDUAL LEARNER)
6
LEARN BETTER IN GROUPS (GROUP LEARNER)
7
LIKE TO TALK TO TELL WHAT YOU'VE LEARNED (EXPRESSIVENESS-ORAL)
8
LIKE TO WRITE TO TELL WHAT YOU'VE LEARNED (EXPRESSIVENESS-WRITTEN)
9
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
NOT SO HOT--YOU LEARN BETTER WITH OTHER STYLES
O.K. YOU LEARN ALRIGHT THIS WAY
BEST STYLE!!!

STUDENT

REFERENCES

Atkinson, J., and Feather, N., eds. *A Theory of Achievement Motivation*. New York: John Wiley, 1966.

Ausburn, L. J. *Impact of Learning Styles on Air Force Technical Training: Relationships among Cognitive Style Factors and Perceptual Types*. Norman, OK: University of Oklahoma, 1979. (ERIC Document Reproduction Service No. ED 174 761)

Bieri, J., et al. *Clinical and Social Judgment: The Discrimination of Behavioral Information*. New York: Wiley, 1966.

Block, J. *Mastery Learning—Theory and Practice*. New York: Holt, Rinehart and Winston, 1971.

Block, J., and Burns, R. *Mastery Learning: Review of Research in Education*. Itasca, IL: F. E. Peacock, 1977.

Bloom, B. *Human Characteristics and School Learning*. New York: McGraw-Hill, 1976.

Brophy, J., and Goode, T. "Teachers' Communication of Differential Expectations for Children's Class Room Performance: Some Behavioral Data." *Journal of Educational Psychology* 61 (1970): 365-374.

Broverman, D. M., et al. "The Automatization Cognitive Style and Physical Development." *Child Development* 35 (1964): 1343-1459.

Bruner, J. S.; Olver, R. R.; and Greenfield, P. M. *Studies in Cognitive Growth*. New York: Wiley, 1966.

Bruner, J., and Tajfel, H. "Cognitive Risks and Environmental Change." *Journal of Abnormal Psychology* 62 (1961): 231-241.

Carroll, J. B. "A Model of School Learning." *Teachers College Record* 64 (1963): 723-733.

Cronbach, L. J. "Intelligence? Creativity? A Parsimonious Reinterpretation of the Wallach-Kogan Data." *American Education Research Journal* 5 (1968): 491-511.

Cronbach, L. J. "How Can Instruction Be Adapted to Individual Differences?" In *Learning and Individual Differences*. Columbus, OH: Charles C. Merrill, 1967.

Cross, P. *Accent on Learning*. San Francisco, CA: Jossey-Bass, 1976.

Dunn, R., and Dunn, K. *Teaching Students through Their Individual Learning Styles*. Reston, VA: Reston Publishing, 1978.

Dunn, R., and DeBello, T. "Learning Style Researchers Define Differences Differently." *Educational Leadership* (February 1981): 372-380.

Florida Department of Education. *Delivering Competency-based Vocational Education.* Tallahassee, FL: Florida Department of Education, 1976.

Gagne, R., and Briggs, L. *Principles of Instructional Design.* New York: Holt, Rinehart and Winston, 1974.

Gardner, R. W. "Cognitive Style: A Study of Individual Systematization in Cognitive Behavior." In *Psychological Issues* 1, 1959.

Gardner, R. W.; Lohrenz, L. S.; and Schoen, R. A. Cognitive Control of Differentiation in the Perception of Persons and Objects. *Perceptual and Motor Skills* 26 (1968): 311-330.

Getzels, J. W., and Jackson, P. W. *Creativity and Intelligence: Explorations with Gifted Children.* New York: Wiley, 1962.

Glaser, R. "Implications of Training Research for Education." In *Theories of Learning and Instruction.* Chicago, IL: University of Chicago Press, 1964.

Gregorc, A. *An Adult's Guide to Style.* Maynard, MA: Gabriel Systems, 1982.

Harvey, O. J.; Hunt, D. E.; and Schroeder, H. M. *Conceptual Systems and Personality Organization.* New York: Wiley, 1961.

Hill, J. E. *The Educational Sciences—A Conceptual Framework.* West Bloomfield, MI: Hill Educational Sciences Research Foundation, 1981.

Hirst, B. "The Components of Competency Based Vocational Education." *American Vocational Journal* (November 1977): 52-3.

Holzman, P. S., and Klein, G. S. "Cognitive System Principals of Leveling and Sharpening: Individual Differences in Assimilation Effects in Visual Time-Errors." *Journal of Psychology* 37 (1954): 105-122.

Hyman, J., and Cohen, S. "Learning for Mastery: Ten Conclusions after 15 Years and 3000 Schools." *Educational Leadership* (November 1979): 104-105.

Ihlenfeldt, W. A. "Using Cognitive Mapping to Capitalize on Learning Strengths." *Training and Development Journal* 35 (May 1981): 99-104.

Jung, C. G. *Psychological Types.* London: Rutledge and Kegan Paul, 1923.

Kagan, J. S. "Reflective Impulsivity and Reading Ability in Primary Grade Children." *Child Development* 336 (1965): 609-28.

Kagan, J. S., et al. "Information Processing in the Child: Significance of Analytic and Reflective Attitudes." *Psychological Monographs: General and Applied* 73 (1964): 1.

Kelly, G. A. *A Psychology of Person Constructs 1.* New York: W. W. Norton, 1955.

Kirby, P. *Cognitive Style, Learning Style, and Transfer Skill Acquisition*. Columbus, OH: National Center for Research in Vocational Education, The Ohio State University, 1979.

Klein, G. S. "Need and Regulation. In *Nebraska Symposium on Motivation*, edited by M. P. Jones. Lincoln, NE: University of Nebraska Press, 1954.

Klein, G. S.; Gardner, R. W.; and Schlesinger, H. J. "Tolerance for Unrealistic Experience: A Study of the Generality of Cognitive Control." *British Journal of Psychology* 54 (1962): 41-55.

Knaak, W. C. "Individualized Competency-based Instruction in Operation." A paper presented at the American Vocational Association Annual Convention, Atlanta, Georgia, December 1981.

Knaak, W. C. "Research in Learning Styles." In *Education in the 80's: Vocational Education*, edited by N. K. Christian. National Education Association of the U.S., 1982.

Kogan, N. "Educational Implications of Cognitive Styles." In *Psychology and Educational Practice*. Glenview, IL: Scott, Foresman, 1971.

Kogan, N., and Wallach, M. A. *Risk Taking: A Study in Cognition and Personality*. New York: Holt, Rinehart, and Winston, 1964.

Kolb, D. "Disciplinary Inquiry Norms and Student Learning Styles: Diverse Pathways for Growth." In *The Modern American College*, edited by A. Chickering. San Francisco, CA: Jossey-Bass, 1981.

Lawrence, G. *People Types and Tiger Stripes: A Practical Guide to Learning Styles*. Gainesville, FL: Center for Applications of Psychological Type, 1979.

Lerner, M. Editorial. *St. Paul* (MN) *Dispatch*, 17 September 1979, p. 5.

Lowenfeld, V. "Tests for Visual and Haptical Aptitudes." *American Journal of Psychology* 58 (1945): 100-112.

McCarthy, B. *The 4 Mat System: Teaching to Learning Styles with Right/Left Mode Techniques*. Arlington Heights, IL: Excel, 1980.

McKenney, J. L., and Keen, P. G. W. "How Managers' Minds Work." *Harvard Business Review* 1974: 79-98.

Messick, S., and Kogan, N. "Differentiation and Compartmentalization in Object Sorting Measures of Categorizing Style." *Perceptual and Motor Skills* 16 (1963): 47-51.

Myers, I. B. *Gifts Differing*. Palo Alto, CA: Consulting Psychologists Press, 1979.

Pettigrew, T. F. "The Measurement and Correlates of Category Width as a Cognitive Variable." *Journal of Personality* 16 (1958): 532-544.

Schlesinger, H. J. "Cognitive Attitudes in Relation to Susceptibility to Interference." *Journal of Personality* 11 (1954): 354-374.

Schmeck, R.; Ribich, F.; and Ramanaiah, N. "Development of a Self-Report Inventory for Assessing Individual Differences in Learning Processes." *Applied Psychological Measurement* 1 (1977): 413-431.

Schroder, H. M.; Driver, M. J.; and Streufert, S. *Human Information Processing*. New York: Holt, Rinehart, and Winston, 1967.

Schwartz, F. G. "Validation of the Generalizing-particularizing Dimension of Cognitive Style and Its Implications for Meaningful Learning." Unpublished doctoral dissertation, City University of New York, 1972.

Wallach, M. A., and Kogan, M. *Modes of Thinking in Young Children*. New York: Holt, Rinehart, and Winston, 1965.

Warner, W. L. "A Development of Competency-Based, Self-Paced Learning Modules for Inservicing Instructors to Implement Cognitive Style Mapping Concepts with Students." Ed.D. dissertation, University of Minnesota, 1981.

Witkin, H. A. Cognitive Style in Academic Performance and in Teacher-student Relations. In *Individuality in Learning*, edited by S. Messick, et al. San Francisco, CA: Jossey-Bass, 1976.

Witkin, H. A. *The Role of Cognitive Style, Academic Performance, and Teacher-Student Relations*. Research Bulletin 73-11. Princeton, NJ: Educational Testing Services, 1973.

Witkin, H. A., et al. *Personality through Perception: An Experimental and Clinical Study*. Westport, CT: Greenwood, 1954.